

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
16 January 2003 (16.01.2003)

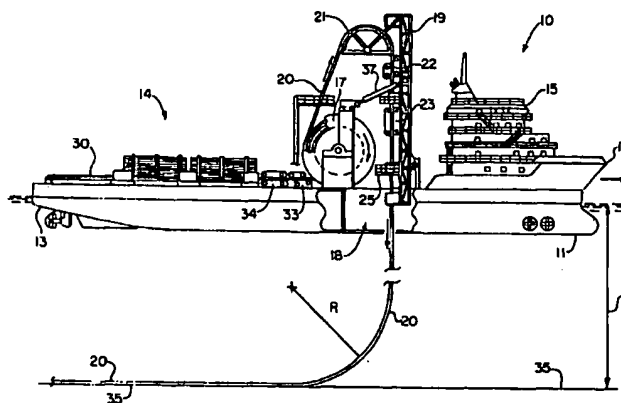
PCT

(10) International Publication Number  
**WO 03/004915 A1**

- (51) International Patent Classification<sup>7</sup>: **F16L 1/12**, (74) Agents: **NORTH, Brett, A. et al.**; 3 Lakeway Center, Suite 3290, 3838 North Causeway Boulevard, Metairie, LA 70002 (US).
- (21) International Application Number: **PCT/US02/21253**
- (22) International Filing Date: **3 July 2002 (03.07.2002)**
- (25) Filing Language: **English**
- (26) Publication Language: **English**
- (30) Priority Data:  
09/898,561 **3 July 2001 (03.07.2001)** US  
10/117,946 **8 April 2002 (08.04.2002)** US
- (71) Applicant (for all designated States except US): **TORCH OFFSHORE, INC.** [US/US]; 401 Whitney Avenue, Suite 400, Gretna, LA 70056 (US).
- (72) Inventor; and  
(75) Inventor/Applicant (for US only): **STOCKSTILL, Lyle** [US/US]; 113 Victoria Drive, Belle Chasse, LA 70037 (US).
- (81) Designated States (national): AE, AG, AL, AM, AT (utility model), AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ (utility model), CZ, DE (utility model), DE, DK (utility model), DK, DM, DZ, EC, EE (utility model), EE, ES, FI (utility model), FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK (utility model), SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZM, ZW.
- (84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).
- Published:  
— with international search report

[Continued on next page]

(54) Title: **REEL TYPE PIPELINE LAYING SHIP AND METHOD**



(57) Abstract: A pipeline laying ship and an improved method of laying a pipeline in a marine environment is disclosed. The pipeline laying ship is a dynamically positioned barge (10) or self-propelled dynamically positioned vessel with a hull (11) having a deck (14) area that supports a pair of reels (16, 17). The reels are independently rotatable, and are positioned generally port and starboard relative to one another. A pipe joint storage area (27-29) is provided for containing multiple joints of pipe. One or more pipeline welding stations (WS-1-3) are provided on the deck next to the reels, the pipeline welding stations being positioned to join the joints of pipe together to form an elongated pipeline that can be wound upon a selected reel of said pair of reels. A tower (19) is provided for guiding the elongated pipeline as it is unwound from a selected reel, the tower including at least a bend controller (21), a straightener (22) and a tensioner (23). The tower is transversely and movably mounted upon the hull between the port and starboard positions that enable a pipeline to be welded and then wound upon either of the reels and to be unwound from either of the reels for launching to the sea bed via the tower. The tower can be mounted upon a transverse track (77, 78). The tower can be positioned aft for launching the pipeline from the hull stern. The tower can be mounted amidships for launching the pipeline through a vertical hull opening or "moon pool" (18).

BEST AVAILABLE COPY



— before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

## PATENT APPLICATION

## TITLE OF THE INVENTION

"REEL TYPE PIPELINE LAYING SHIP AND METHOD"

5 INVENTOR(S): STOCKSTILL, Lyle, a US citizen, of 113 Victoria Drive, Belle Chasse, LA, 70037;

## CROSS-REFERENCE TO RELATED APPLICATIONS

Priority is claimed to US Patent Application Serial No. 09/898,561, filed 03 July 2001, which is incorporated herein by reference.

10 Priority is claimed to US Patent Application Serial No. 10/117,946, filed 08 April 2002, which is incorporated herein by reference.

## STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not applicable

15 REFERENCE TO A "MICROFICHE APPENDIX"

Not applicable

## BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to the placement of pipelines in a marine environment. More particularly, the present invention relates to an improved method and apparatus for laying a pipeline in a marine environment, wherein a specially configured pipeline laying ship provides a hull with a deck area and having a pair of reels independently rotatable during use, wherein a pipeline fabricating "firing line" fabricates a pipeline that is then wound upon a selected one of the reels. The pipeline "firing line" can be moved in order to align with either of the reels that is selected. Additionally, the pipeline can be payed out from either of the selected reels after it has been fabricated. A tower is provided for directing the pipeline from a reel through bend control and straightening stations and then to the seabed. The tower can be positioned at the vessel stern, or amidships for launching the pipeline through a vertical hull opening or "moon pool".

30 2. General Background of the Invention

For many years, pipelines have been fabricated at sea and lowered to the seabed at a desired location. For example, early patents to Tesson include US numbers 3,237,438 and

3,337,469 that are directed to a pipeline laying barge and method of operation. In the Tesson patents, the joints of pipe are welded on deck and then spooled or wound upon a reel. At a desired location, the pipeline is then placed on the seabed by unwinding the pipe from the reel and straightening it before it is lowered to the seabed.

5 A tilting tower has also been used to lower a pipeline to the seabed as the pipeline is being unwound from a reel. An example of such a tilting tower and reel pipeline laying arrangement can be seen in the Uyeda patent 4,345,855 as an example. A similar arrangement is seen in the Springett patent 4,340,322. The Uyeda patent 4,345,855 and the Springett patent 4,340,322 are hereby incorporated herein by reference. Another method of laying a pipeline is  
10 through the use of a stinger. A stinger is simply an elongated boom structure that extends from usually one end of a hull or barge. The stinger supports the pipeline as it is being lowered to the seabed. Examples of the use of stingers can be seen in US Patent numbers RE28,922, RE29,591 and 5,533,834.

Reel type pipeline laying systems are typically employed in deep water situations. While  
15 it is known to weld the pipeline joints on the deck of a vessel and wind them upon a reel (for example, see the above discussed Tesson patents), it is also known to weld the pipeline on shore and then wind it upon the reel before the ship leaves port.

The following table provides an exemplary listing of patents that are known to applicant and that relate to pipeline laying vessels and methods of operation:

20 **MARINE PIPE LAYING PATENTS**

<u>PAT. NO.</u>	<u>TITLE</u>	<u>INVENTOR</u>
3,237,438	Pipe Line Laying Barge	Tesson
3,372,461	Method of Laying Pipeline	Tesson
Re.28,922	Column Stabilized Stinger	Lloyd, III
25 3,982,402	Submarine Pipeline Laying Vessel	Lang et al.
Re.29,591	Column Stabilized Stinger Transition Segment And Pipeline Supporting Apparatus	Lloyd
4,112,695	Sea Sled For Entrenching Pipe	Chang et al.
30 4,165,571	Sea Sled With Jet Pump For Underwater Trenching And Slurry Removal	Chang et al.
4,218,158	Pipe Handling Method And Apparatus	Tesson
4,230,421	Self Propelled Dynamically Positioned Reel Pipe Laying Ship	Springett et al.

	4,260,287	Portable Reel Pipelaying Method	Uyeda et al.
	4,268,190	Pipe Handling Method And Apparatus	Tesson
	4,269,540	Self Propelled Dynamically Positioned Reel Pipe Laying Ship	Uyeda et al.
5	4,297,054	Method of Laying Offshore Pipeline From a Reel Carrying Vessel	Yenzer et al.
	30,846	Submarine Pipeline Laying Vessel	Lang et al.
	4,340,322	Self Propelled Dynamically Positioned Reel Pipe Laying Ship	Springett et al.
10	4,345,855	Self Propelled Dynamically Positioned Reel Pipe Laying Ship	Uyeda et al.
	4,486,123	Underwater Pipe Laying Vessel	Koch et al.
	4,687,376	Multi-Reel Operational Lines Laying Vessel	Recalde
15	4,721,411	Multi-Reel Operational Lines Laying Vessel	Recalde
	4,723,874	Multi-Reel Operational Lines Laying Vessel	Recalde
	4,765,776	Convertible Barge	Howson
20	4,789,108	Multi-Reel Operational Lines Laying Vessel	Recalde
	4,820,082	Pipeline Laying System And Vessel	Recalde
	4,917,540	Pipeline Laying System And Vessel With Pipeline Straightening And Tensioning Device	Recalde
25	4,961,671	Method of Converting a Pipeline Laying Vessel From a Pivotal Ramp Type To An Arcuate Type	Recalde
	4,984,934	Pipeline Laying System And Vessel And Method of Spooling Lines Onto The Vessel	Recalde
30	5,044,825	Method And Installation For Laying a Pipeline	Kaldenbach
	5,413,434	Method And Installation For Laying a Pipeline	Stenfert et al.
35	5,527,134	Pipelaying Vessel	Recalde
	5,533,834	Pipelay Stinger	Recalde
	5,836,719	Pipe Laying Vessel and Method	Martin et al.

5,971,666	Pipe Laying Vessel	Martin et al.
5,975,802	Pipeline Laying Apparatus	Willis
6,004,071	Methods of Installing Elongate Underwater Structures	Broeder et al.

5	<u>PATENT</u>	<u>TITLE</u>	<u>ISSUED</u>
	WO9525238A1	Pipe Laying Vessel and Method	Sept. 21, 1995
	WO9525237A1	Pipe Laying Vessel and Method	Sept. 21, 1995
	AU1898395A1	Pipe Laying Vessel and Method	Oct. 03, 1995
10	AU1898295A1	Pipe Laying Vessel and Method	Oct. 03, 1995
	AU4088796A1	Pipeline Laying	July 25, 1996
	AU676431B2	Pipe Laying Vessel and Method	Mar. 06, 1997
	AU681014B2	Pipe Laying Vessel and Method	Aug. 14, 1997
	AU696337B2	Pipeline Laying	Sept. 10, 1998
15	BR9507088A	Processo Para Assentar Uma Tubulacao Submarina E Embarcacao Para Ser Utilizada No Assentamento De Uma Tubulacao Submarina	Sept. 16, 1997
20	BR9507064A	Processo Para Assentar Uma Tabulacao Submarina E Embarcacao Para Ser Utilizada No Assentamento De Uma Tubulacao Submarina	Oct. 14, 1997
25	BR9600055A	Sistema De Colocacao De Tubos Navio Conduzindo Um Sistema De Colocacao De Tubos E Processo Colocacao De Uma Tubulacao De Um Navio	Jan. 21, 1998
30	GB2287518B	Pipe Laying Vessel and Method	Mar. 12, 1997
	GB2287518A	Pipe Laying	Sept. 20, 1995
	GB2296956B2		Mar. 10, 1999
	GB2296956B	Pipeline	Mar. 10, 1999
35	GB2296956A1		Jul. 17, 1996
	GB2296956A	Pipeline Laying with Bending and Straightening	Jul. 17, 1996
	GB2302157B	Pipe Laying Vessel and Method	Nov. 12, 1997

	GB2302157A	Pipe Laying Vessel and Method	Jan. 08, 1997
	GB9411702A0		Aug. 03, 1994
	GB9500664A0		Mar. 8, 1995
	GB9505344A	Pipe Laying Vessel and Method	May 03, 1995
5	GB9600005A0		Mar. 06, 1996
	GB9600005A	Pipeline Laying	Mar. 06, 1996
	GB9619167A	Pipe Laying Vessel and Method	Oct. 23, 1996
	NO960135A0	Roerlednings-leggesystem	Jan. 11, 1996
	NO960135A	Roerlednings-leggesystem	Jul. 15, 1996
10	NO963858A0	Roerleggingsfartoy Og Fremgangsmaate	Sept. 13, 1996
	NO963858A	Roerleggingsfartoy Og Fremgangsmaate	Nov. 11, 1996
15	NO963857A0	Roerleggingsfartoy Og Fremgangsmaate	Sept. 13, 1996
	NO963857A	Roerleggingsfartoy Og Fremgangsmaate	Nov. 11, 1996

#### GENERAL DISCUSSION OF THE PRESENT INVENTION

The present invention provides an improved pipeline laying vessel and its method of operation. The method preferably employs a dynamically positioned barge or self-propelled dynamically positioned reel ship that has two independently rotatable reels or drums. The ship has a deck area that enables pipe joints to be welded together to form a pipeline. Joints of pipe are placed in a storage area on the deck of a vessel in suitable pipe racks. Welding stations near this storage area are arranged to receive multiple joints of pipe that have been internally cleaned and prepared for welding. Part of this preparation can include, for example, end bevels that are applied to the pipeline and to individual pipe joints.

As pipeline fabrication proceeds, pipe joints are moved from the rack storage areas to the pipeline fabrication area, also referred to herein as the "firing line."

This fabrication area or "firing line" can comprise essentially a set of rollers supporting the pipeline along the center line of the fabrication area. Welding equipment (manual or automatic) can be provided together with known weld preparation tools.

The incoming pipe joints are aligned with the pipeline being fabricated. The welded area between the pipe joints and the joints previously welded together can be adjusted as required. The pipe joints are progressively welded together to form a pipeline at multiple welding stations.

The welds are tested and field joints are then coated at another work station located in the pipeline fabrication area.

When one or more joints of pipe have been welded together end-to-end on the firing line, a selected reel or drum is readied for storage of the assembled pipeline on provided reels or drums. In keeping with the present invention, two (2) reels or drums are provided. A selected length (eg. about 40 feet or 12.192 m) of pipeline is advanced at any time and wound upon the reel by plastic bending. The pipeline moves ahead in the pipeline fabrication area by the same distance (eg. 40 feet increments or 12.192 m increments) through a back tensioning device.

The pipeline welding progresses until the selected drum or reel is filled with the pipeline that is being welded on the deck of the vessel. Each reel or drum can be between 30 and 50 feet in diameter (9.144 and 15.24m), have a width of between about 10-20 feet (3.048-6.096m), and store, eg. 30,000-50,000 feet (9.144-15.24 km) of six inch (15.24 cm) pipe.

In order to arrange properly the pipeline on the selected reel drum during spooling, the firing line travels from one side of the ship to the other side in a coordinated back and forth direction to spool each wrap of the pipeline next to the previous wrap on the reel.

The firing line can also be configured to travel from one side of the ship to the other side if it is to align with the second drum, so that the pipeline fabricated on the ship deck can be spooled on either one of the reels. In other words, the pipeline "firing line" moves laterally as it is being spooled upon a first reel. However, the entire firing line can travel transversely on the ship's deck a larger distance in order to align with the second reel when the second reel is to be filled with pipeline.

When the ship undertakes pipe laying on the sea bottom, the pipeline that is stored on a selected reel leaves the drum in a direction tracking toward the top of the tilting tower. The tilting tower can tilt in a position that varies such as for example between about 65 and 95 degrees from the deck plane. At the top of the tower, the pipeline bends through a bend controller downwardly toward the seabed. The tilting tower can also be provided with a device for straightening the pipeline, a tensioning device and a clamping device that can hold the pipeline and support the weight of the pipeline that extends downwardly toward the seabed.

It should be understood that the general concept of paying a wound pipeline from a reel to a tilting tower that has a bend controller, straightener, tensioner, and clamp mechanism is old and known in the art such as is shown in the above discussed Springett 4,340,322 and Uyeda 4,345,855 patents, each incorporated herein by reference.



With the improved arrangement of the present invention, the tower can move transversely in a port to starboard direction and in a starboard to port direction for two reasons. The firing line can also be moved if necessary. The tower can move transversely in order to coordinate with the reel rotation. This arrangement enables spooling the welded pipeline upon the reel or removing pipeline from the reel in an orderly fashion. Secondly, the firing line and tilting tower can be moved transversely in order to align with either the first or the second drum as selected by the vessel operators. This larger transverse movement occurs when winding of the pipeline on the first reel is complete, and the winding of the pipeline on the second reel begins.

When leaving the bend controller, the pipeline passes through a straightening device that imposes a reversed plastic bending on the pipeline in order to straighten it. The straightened pipeline then passes through a vertical tensioner. The combined tension imposed on the pipeline by the tensioner and the drum back tension compensates for the suspended weight of the pipeline during its travel from the ship to the sea bottom. This tension is adjusted depending on the various pipe laying parameters such as pipeline characteristics (eg. diameter, wall thickness, coating, alloy, wet or dry lay) and water depth during lay operations. The proper tilting of the tower and the coordination of the tension with the ship as it moves along the pipeline route ensure that the stresses in the pipeline are maintained within predetermined predefined acceptable limits.

The area in between the last tensioner and the clamping mechanism or "hold off" clamp can be used to support the pipeline and install corrosion anodes and insulation coating when required on the pipeline joints that are welded in the pipeline fabrication area or "firing line," or in the tower itself. A work station can be used to initiate the pipeline, lay down, and testing devices at the beginning and the end of the pipeline lay operations from either of the two reels.

The pipeline eventually leaves the ship after passing through the hold off clamp that has the ability to hold the pipeline suspended weight during lay down operations.

For pipelines that cannot be coiled on the reel drums, the tilting tower can be arranged to weld pipeline joints at one work station and to perform nondestructive testing and field joint coating at another work station.

The tension required to hold the weight of the suspended part of the pipeline being laid is being provided by the tensioner located on the tilting ramp and, when required, by the tension from an A & R (abandonment and recovery) winch wire. This wire can be routed to the top end of the pipeline through a sheave located on top of the tower. In this case, collars are welded to

the linepipe and are used to transfer the A & R winch rope tension to the pipeline.

When an umbilical or flexible line installation is required, the ship can load this product in either a large capacity rotating basket located, for example, below deck, or on several smaller reels located on the ship deck, depending on the number of products, product length, and pipe  
5 characteristic, or on one or both of the main reels.

Such products can be laid on the sea bottom independently or simultaneously with the pipeline and attached as a "piggyback" to the pipeline in the work station located in the tower. The product can be conveyed out of the storage areas to a position next and parallel to the pipeline in the tower by a second bend controller.

10 When a smaller diameter pipeline is to be laid (for example 2 inch - 6 inch or 5.08 cm- 15.24 cm) with the main pipeline and as a piggyback to the main pipeline, this smaller pipeline is preferably fabricated on shore and stored on reels located on the ship's deck. This smaller pipeline is conducted to the same position described above for umbilicals and flexible lines in the tower or work station. In this case, the small diameter pipeline is plastically bent and is  
15 straightened by another straightening device installed next to the one used for the main pipeline.

The present invention thus provides a method and apparatus for laying rigid pipelines, such as for example between 3 and 12 inches (7.62 and 30.48 cm) in diameter, on a sea bed and to lay, simultaneously or in sequence, long lengths of flexible products (umbilicals) and simultaneously limited lengths of small diameter (between about 2 inches and 6 inches or 5.08  
20 to 15.24 cm) rigid pipelines. The system of the present invention thus provides a dynamically positioned ship of adequate length, width and depth.

The ship provides a deck that has multiple areas for storing pipeline lengths (linepipe or pipe joints). The deck provides an area for fabricating the pipeline from line pipe (firing line). A pair of storage reels are provided, preferably port and starboard reels. These reels or drums  
25 are powered separately from each other. Each drum or reel provides a back tension of, for example about 50 Te on the pipeline when it is used for pipe laying.

An area below deck can be provided to locate flexible products storage including for example a rotating basket.

An area on the deck is provided to locate multiple storage reels and their drives.

30 An opening on the deck is provided to load and unload flexible products into the below deck rotating basket.

An opening can be provided in the ship's hull (moon pool) located, for example,

approximately amidship.

A tilting tower is provided that preferably tilts between about 65 and 90 degrees from the deck plane.

5 A pipeline hold off clamp is located at the bottom end of the tilting tower. A retractable enclosure can be located at the middle part of the tilting tower to protect a provided work area.

Multiple pipeline tensioning devices can be provided, one located on the ship deck and one or two located vertically on the upper part of the tilting tower.

10 A device can be provided for straightening the pipeline during laying. A pipeline guiding device can be provided to conduct the pipeline from the reel that is used for pipe laying to the bend controller and straightener located on the tower.

A flexible product and small diameter rigid pipeline guiding device can be provided for conducting such products from their storage area on or below deck to the entry of the straightener.

Multiple work stations, such as welding stations can be provided on the tower.

15 A winch can be located below deck for lowering the pipeline to the sea floor when pipe laying is completed.

Multiple retractable sheaves can be used in conjunction with the winch.

20 The present invention thus provides an improved pipeline laying ship and its method of operation. The improved reel ship apparatus of the present invention includes a dynamically positioned barge or self-propelled dynamically positioned ship having a deck. A pair of reels or drums are supported upon the deck, each reel or drum being powered and independently rotatable. The reels are preferably positioned port and starboard relative to one another.

A pipe joint storage area is provided on the deck that contains multiple joints of pipe.

25 One or more pipeline welding stations on the deck define a "firing line" that is positioned next to the reels. The pipeline welding stations are also positioned to join the joints of pipe together to form an elongated pipeline that can be wound upon a selected reel of said pair of reels.

30 After a selected reel has been filled with a pipeline, a tower is provided for guiding the elongated pipeline as it is unwound from the selected reel during the pipeline laying operation. The tower can include a bend controller, a straightener, a tensioner and a clamp mechanism.

The welding stations and tower are movably mounted upon the hull along a transverse path between port and starboard positions. This enables a pipeline to be welded and then wound

upon either of the reels. Later, the pipeline can be unwound from either of the reels for launching to the sea bed via the tower.

The reels are preferably each supported to rotate about a generally horizontal axis.

The reels are preferably positioned generally parallel to one another and generally in  
5 between the pipeline welding stations on deck and the tower.

The present invention provides an improved method of laying a pipeline on a sea bed. The method first progressively joins joints of pipe (eg. 40 foot joints or 12.192m) together upon the deck of a vessel at a firing line to form a long pipeline. The vessel includes a pair of reels and a tower for launching the pipeline. The method includes winding the pipeline upon a selected  
10 reel of the pair of reels as the lengths pipe are joined (eg. welded) together at the firing line.

The method further includes the step of bending the pipeline to approximate the curvature of a reel before winding the pipeline upon the selected reel. With the present invention, one reel can be paying out a completed pipeline for placement on the seabed while the other reel is simultaneously being wound with a pipeline as it is being fabricated at the firing line. Two or  
15 more pipelines can be fabricated, reeled and then unwound for placement, and, if desired, joined together to make one very long pipeline.

After a selected reel is fully wound with a pipeline of selected length, the selected reel is moved along a path in which the pipeline is to be laid while unwinding the pipeline from the reel and simultaneously straightening the pipeline.

20 The method of the present invention provides that the reels are independently rotatable so that either reel can be wound with a pipeline independently of the other.

The method further includes the step of moving the firing line in a port to starboard direction that aligns the pipeline as it is being formed with a selected reel.

The method of the present invention also includes moving the tower in a port to starboard  
25 direction that aligns the tower with a selected reel during unwinding.

The reels preferably rotate about a generally horizontal axis and the method can further include the step of passing the straightened pipeline through a tensioner.

In the method of the present invention, the combined tension imposed on the pipeline by the tensioners and a drum back tension compensate for the suspended weight of the pipeline  
30 during its travel from the hull to the sea bed.

The method of the present invention further comprises the step of adjusting the tension on the pipeline depending upon pipeline laying parameters that include pipeline characteristics

and water depth during pipe laying operation.

The method further includes providing a tower to guide the pipeline from a selected reel to the sea bed. The tower can be provided amidships for launching the pipeline through a vertical hull opening or "moon pool". The tower can be placed at the hull stern, behind the reels for  
5 launching the pipeline off the vessel stern. The method further comprises the step of coordinating the tension applied by the tensioner as the ship moves along the pipeline route to insure that the stresses in the pipeline are maintained with an acceptable limit.

The method of the present invention further includes the step of using a hold off clamp to support the pipeline so that corrosion anodes and insulation coating can be applied thereto. A  
10 moon pool can be provided for receiving the pipeline from the tower for launching to the seabed. Alternatively the tower can be positioned at the vessel stern for launching the pipeline off the stern.

#### DESCRIPTION OF THE DRAWINGS

For a further understanding of the nature, objects, and advantages of the present  
15 invention, reference should be had to the following detailed description, read in conjunction with the following drawings, wherein like reference numerals denote like elements and wherein:

Figure 1 is an elevation view showing the preferred embodiment of the apparatus of the present invention and illustrating the method of the present invention;

Figure 1A is another elevation of the preferred embodiment of the apparatus of the  
20 present invention showing the tower in a tilted orientation;

Figure 2 is a plan view of the preferred embodiment of the apparatus of the present invention and showing the method of the present invention;

Figure 3 is a fragmentary perspective view of the preferred embodiment of the apparatus of the present invention and illustrating the method of the present invention;

25 Figure 4 is a fragmentary perspective view of the preferred embodiment of the apparatus of the present invention illustrating the method of the present invention;

Figure 5 is a fragmentary view of the preferred embodiment of the apparatus of the present invention and illustrating the method of the present invention;

Figure 6 is an enlarged fragmentary, plan view of the preferred embodiment of the  
30 apparatus of the present invention and illustrating the method of the present invention and illustrating the method of the present invention;

Figure 7 is an elevation view showing an alternate embodiment of the apparatus of the

present invention and illustrating an alternate method of the present invention;

Figure 8 is a plan view of the alternate embodiment of the apparatus of the present invention and illustrating the alternate method of the present invention;

Figure 9 is a perspective view of an alternate embodiment of the apparatus of the present invention;

Figures 10A - 10B are elevation views of an alternate embodiment of the apparatus of the present invention; and

Figures 11A - 11B are plan views of the alternate embodiment of the apparatus of the present invention.

## 10 DETAILED DESCRIPTION OF THE INVENTION

The attached drawing figures 1 and 2 show a reel-type dynamically positioned barge or self-propelled dynamically positioned pipeline laying ship 10 that includes a hull 11 having bow 12 and stern 13 portions. A deck 14 supports a superstructure 15 that can include for example, accommodations for the crew, sleeping quarters, a galley, hospital, heliport, and the like. As pipeline fabrication proceeds, pipe joints are moved one by one from pipe rack storage areas 27, 28, 29 to the pipeline fabrication area, also referred to as the firing line 30.

This fabrication area or "firing line" 30 can comprise essentially a set of rollers supporting the pipeline 20 along the center line of the fabrication area 30. Welding equipment (manual or automatic) can be provided together with known weld preparation tools. The firing line 30 can be comprised of one or more welding stations.

Firing line 30 is an area of the deck that is a designated area for welding sections of pipe together to form a pipeline 20 that will be reeled upon a selected one of the drums or reels 16 or 17. These drums or reels 16 and 17 are preferably independently driven and independently rotatable.

Incoming pipe joints are aligned with the pipeline being fabricated. The welded area between the pipe joints and the joints previously welded together can be adjusted as required. The pipe joints are progressively welded together at multiple welding stations to form a pipeline 20.

In the stern area of the deck 14, a plurality of pipe storage racks 27, 28, 29 can be provided such as those shown in Figure 2. Welding stations are positioned near these storage areas 27, 28, 29 and arranged to receive multiple joints of pipe that have been internally cleaned and prepared for welding. Part of this preparation can include, for example, end bevels that are

applied to the pipeline. The welds are tested and field joints are then coated at another work station located in the pipeline fabrication area or firing line 30.

5 A trapezoidal through hull opening or moon pool 18 is provided amidships through which the pipeline 20 can be launched for placement on the seabed. A tilting tower 19 is supported by the hull 11 next to the moon pool 18, as shown in Figures 1 and 2. The moon pool 18 is preferably positioned in front of reels 16, 17 and behind the tilting tower 19. However, an alternative deck plan could position the tower 19 at stern 13. The reels 16, 17 could then be positioned near the stern 13 and in front of the tilting tower 19.

10 The tilting tower 19 includes a number of components including a bend controller 21, pipe straightener 22, tensioner 23, hold-off clamp 24, and a pair of welding stations at 25, 26.

The double arrows 31 in Figure 2 indicate schematically that the firing line 30 can be selectively shifted between port and starboard positions along a transverse path. In this fashion, the pipeline 20 that is being welded upon the firing line 30 can be spooled upon either of the reels 16 or 17. The firing line 30 moves to port or to starboard in order to align with the selected  
15 reel 16 or 17.

A bending shoe 33 and tensioner 34 can be used to bend and tension the pipeline after it is welded and as it is being spooled upon a selected one of the drums 16 or 17. Each of these components (shoe 33 and tensioner 34) preferably move between port and starboard positions as indicated by arrows 31. As welding is completed, a selected reel 16 or 17 is readied for  
20 storage. In keeping with the present invention, two (2) reels or drums 16, 17 are provided. About 40 feet (12.192m) of pipeline is advanced and wound upon the selected reel by plastic bending. The pipeline 20 moves ahead in the pipeline fabrication area by the same distance (eg. forty feet increments or 12.192m) through a back tensioning device.

When the ship 10 undertakes pipe laying on the sea bottom 35, the pipeline 20 that is  
25 stored on a selected drum 16 or 17 leaves the drum 16 or 17 in a direction tracking toward the top of tilting tower 19. At the top of the tower 19, the pipeline 20 bends through a bend controller 21 downwardly toward the seabed 35. The tilting tower 19 can be provided with bend controller device 21 for bending the pipeline, a straightener 22 for straightening the pipeline, a tensioner 23 and a clamping device 24 that can hold the pipeline 20 and support the weight of  
30 the pipeline 20 that extends downwardly toward the seabed 35. When it is time to lay the pipeline 20, the tilting tower 19 can move between port and starboard positions as indicated schematically by the double arrow 32 in Figure 2. The tilting tower 19 can align with a selected

drum such as with the drum 17 in Figure 2 as shown. The tilting tower 19 can tilt in a position that varies such as, for example, between about 65 and 90 degrees from deck plane 36.

With the improved arrangement of the present invention, the firing line 30 and tower 19 both move transversely back and forth for two reasons. The firing line 30 and tower 19 move transversely in order to coordinate with the reel rotation, thus spooling the welded pipeline 20 upon the selected reel in an orderly fashion. Secondly, the firing line 30 and tilting tower 19 move transversely in order to align with either the first 16 or the second 17 reel as selected by the vessel operators. This larger transverse movement occurs when winding of the pipeline 29 one the first reel 16 is complete, and the winding of the pipeline on the second reel 17 begins.

When leaving the bend controller 21, the pipeline 20 passes through straightening device 22 that imposes a reversed plastic bending on the pipeline 20 in order to straighten it. The straightened pipeline 20 then passes through vertical tensioner 23. The reel back tension compensates for the suspended weight of the pipeline 20 during its travel from the ship hull 11 to the sea bottom 35. This tension is adjusted depending on the various pipe laying parameters such as pipeline characteristics and water depth during lay operations. The proper tilting of the tower 19 and the coordination of the tension as the hull 11 moves along the pipeline route ensure that the stresses in the pipeline 20 are maintained within a predetermined, predefined acceptable limits. Hydraulic cylinder 37 can be used to tilt tower 19 (see figures 1 and 1A).

The welding station 25 in between the last tensioner 23 and the clamping mechanism or "hold off" clamp 24 can be used to support the pipeline 20 and install corrosion and insulation coating when required on the pipeline joints that are welded in the pipeline fabrication area 30 or "firing line," or in the tower 19 itself. A welding station 25 or 26 can be used to install pipeline initiation, lay down, and testing devices at the beginning and the end of the pipeline lay operations from either of the two reels 16, 17.

The pipeline 20 eventually leaves the ship hull 11 after passing through the hold off clamp 24 that has the ability to hold the pipeline suspended weight during lay down operations. For pipelines 20 that cannot be coiled on the reel drums, 16, 17 the tilting tower 19 can be arranged to weld pipeline joints at one welding station 25 and to perform nondestructive testing and field joint coating at another welding station 26.

The tension required to hold the weight of the suspended part of the pipeline 20 being placed is being provided by the tensioner 23 located on the tilting tower. Assistance can be provided by the tension from an A & R winch wire to support the suspended weight of the



pipeline 20. A winch wire can be routed to the top end of the pipeline 20 through a sheave located on top of the tower 19. In this case, collars are welded to the pipeline 20 and are used to transfer the A & R winch rope tension to the pipeline 20.

5 When an umbilical or flexible line installation is required, the ship 10 can load this product in either a large capacity rotating basket located for example below deck, or on one or both of the main reels 16, 17, or on several smaller reels located on the ship deck 14, depending on the number of products, product length and characteristics.

Such products can be placed to the sea bottom independently or simultaneously with the pipeline and attached as a "piggyback" to the pipeline in the work station located in the tower  
10 and the work station. The product is conducted out of the storage areas to a position next and parallel to the pipeline in the tower by a second bend controller.

When smaller diameter pipeline is to be placed (for example, 2 inch - 6 inch or 5.08-15.24cm) with the pipeline as a piggyback to the pipeline, this smaller pipeline is preferably fabricated on shore and stored on reels located on the ship's deck 14. This pipeline is conducted  
15 to the same position described above for umbilicals and flexible lines in the tower or work station. In this case, the small diameter pipeline is plastically bent around the system and second conduit and is straightened by another straightening 30 device installed next to the one used for the main pipeline.

The present invention thus provides a method and apparatus for laying rigid pipelines,  
20 such as for example between 3 and 12 inches (7.62 and 15.24cm) in diameter, on a sea bed and to lay, simultaneously or in sequence, long lengths of flexible products (umbilicals) and simultaneously limited lengths of small diameter (between about 2 inches and 6 inches or 5.08 and 15.24cm) rigid pipelines. When a smaller diameter pipeline is to be laid (for example 2 inch - 6 inch or 5.08-15.24cm) with the pipeline as a piggyback to the pipeline this smaller pipeline  
25 is preferably fabricated on shore and stored on reels located on the ship's deck. This pipeline is conducted to the same position described above for umbilicals and flexible lines in the tower or work station. In this case, the small diameter pipeline is plastically bent around the system and second conduit and is straightened by another straightening device installed next to the one used for the main pipeline.

30 One feature of the present invention is that one drum 16 can be loaded with a pipeline 20 as it is being welded together as a first operation independent of pipe laying. The other drum (previously loaded with a pipeline) can be rotated to pay out the pipeline 20 independently of the

other drum, and route it through the tilting tower 19 and its components 22, 23, 24, 25, 26 to the moon pool 18 and then downwardly to lay upon the seabed. The invention has unique features that include the laterally traversing firing line and the two independently driven drums, either of which can, independently of and/or simultaneously with the other, receive a welded pipeline to be spooled, or pay out a spooled pipeline to be placed on the seabed 35.

Figures 7 and 8 show an alternate embodiment of the apparatus of the present invention designated generally by the numeral 10A. In figures 7 and 8, reel pipeline lay barge 10A has a hull 11 that is similarly configured to the embodiment of figures 1-6. However, the lay barge 10A of figures 7 and 8 provides a different positioning for the port and starboard drums 16,17, the moon pool 18, and the tilting tower 19. In figures 7 and 8, the reels or drums 16,17 are closer to the bow 12 of the hull 11. The tilting tower 19 is positioned immediately aft drums 16,17. Moon pool 18 is positioned aft tilting tower 19. The tilting tower 19 is thus positioned in between the moon pool 18 and the pair of drums or reels 16,17.

The tower 19 can be tilted using boom 38. Boom 38 can be connected to any suitable support 40 on hull 11 using, for example, a pinned connection 39.

A traveling member 42 can be slidably affixed to boom 38. The traveling member 42 can, for example, be one or more hydraulic cylinders that can be expanded or retracted during use. The boom 38 provides openings for 43 that are preferably regularly spaced along the length of the boom 38. Pins can be provided at end portions of the hydraulic cylinders for engaging the openings 43. The pins are preferably remotely operable using pneumatic or electrical controllers. In this fashion, the pins 44 can be inserted into selected of the openings 43 as the hydraulic cylinders are expanded and then contracted. The traveling member 42 can be moved in a ratchet fashion along the length of the boom 38 to change the angular position of the tilting tower 19 relative to deck 14. The traveling member 42 can thus be pinned at pinned connection 41 to tilting tower 19. Alternatively, a rack and pinion gear arrangement can interface between boom 38 and traveling member 42.

Figures 9, 10A - 10B and 11A - 11B show an alternate embodiment of the apparatus of the present invention designated generally by the numeral 10B. Reel pipe line lay barge 10B includes a hull 45 having a bow 46 and stern 47. The hull 45 has a deck 48 that supports a super-structure 49.

A pair of drums are mounted on the deck 48 of hull 45. These drums include a port drum 50 and a starboard drum 51.

At the stern 47 of hull 45, tilting tower 52 is attached to the deck 48 at a pair of provided tracks 77, 78. The tracks 77, 78 are generally parallel to one another and are perpendicular to the vessel longitudinal center line, running in a port to starboard direction as shown in figures 9 and 11A.

5 A pipeline 53 is fabricated at firing line 63 with a plurality of welding stations 58. Arrows 64 indicate generally the direction of travel of the pipeline 53 as it is fabricated at welding stations 58. Pipeline 53 is coiled upon a selected one of the drums 50, 51. In order to align the welding stations 58 of firing line 63 with a particular drum 50 or 51, tracks 82 are provided that run in a port to starboard direction. The tracks 82 are attached firmly to deck 48 and enable each  
10 of the welding stations 58 to travel transversely (see arrows 67, figure 11A) in a port to starboard direction or in a starboard to port direction, as required in order to align the pipeline 53 being welded with either the port drum 50 or the starboard drum 51.

A bending shoe 66 or like pipe bender bend the pipeline 53 before it is spooled upon a selected reel 50 or 51. A pipe bending station 54 or tower 52 provides a bend control for the  
15 pipeline 53 that is to be spooled upon a selected drum 50 or 51. A pipe straightener 55 is provided for straightening the pipeline before it is to be launched to the sea bottom 68. The pipe straightener 55 is preferably mounted upon tilting tower 52.

Tensioners 56 can also be provided at selected locations. A tensioner 56 can be placed next to the welding stations 58 on deck 48. A tensioner (not shown) can also be placed on the  
20 tilting tower 52. The tilting tower 52 can also provide a hold off clamp such as clamp 24 in the preferred embodiment and a welding station 59 at a location generally in between bending station 54 and hold off clamp 57.

One or more pipe storage areas or racks 60, 61, 62 are provided next to the welding stations 58, preferably to one side of the tracks 82, such as on the port side thereof as shown in  
25 the drawings. Boom 71 mounted upon support 73 can transfer pipe joints from a dock or work boat to deck 48.

A bend controller 54 is provided at the upper end portion of tilting tower 52 as shown for bending the pipeline in a controller manner as it travels from a selected reel 50 or 51 to tilting tower 52. Arrows 65 indicate schematically the travel of pipeline 53 from a selected spool or  
30 drum 50, 51 to bend controller 54 of tilting tower 52.

In order to lay the pipeline 53, one of the reels or drums 50, 51 that has been wound with the pipeline 53 is used to unwind the pipeline 53 as shown by arrow 65 so that it can track the

bend control 54 and travel through the tilting tower 52 to the water's surface 81 and then to the sea bottom 68.

Tilting tower 52 can be tilted using hydraulic cylinders 70, each hydraulic cylinder providing a cylinder 80 portion and an extensible rod 79. A pair of tracks 77, 78 are provided  
5 behind reels 50, 51 and in between reels 50, 51 and the stern 47 of hull 45 as shown.

Tracks 77, 78 have traveling members or carriages 75, 76 that travel upon the tracks 77, 78 respectively. Stops 73 can be provided at ends of tracks 77,78 to limit the travel of carriages 75,76 upon tracks 77,78.

A lower end portion of each of the hydraulic cylinders 70 attaches to a traveling member  
10 75 on forward track 77 at pinned connection 74. Pinned connections 83 are provided for attaching each hydraulic cylinder 70 to tilting tower 52. Tilting tower 52 provides forwardly extending portions 84 that form pivotal connections at 72 with the traveling members 76 that travel upon rear track 78.

The above described connection of tilting tower 52 to hull 45 enables tilting tower 52 to  
15 move laterally as indicated by arrows 57 in figures 9 and 11A and to tilt to a desired angle with respect to the vessel deck plane 69. The described connections between tilting tower 52 and hull 45 also enable the tilting tower 52 to move upon its tracks 77, 78 between port and starboard positions that align it with either the port drum 50 or the starboard drum 51. Thus, the tilting tower 52 can receive a pipeline 53 that is to be unwound from either of the drums 50 or 51.  
20 Similarly, the laterally movable pipeline firing line 63 enables a pipeline to be welded on the deck 48 and wound more easily upon either of the drums 50 or 51.

One of the features of the present invention is that both of the drums 50 and 51 can be used at the same time, one drum 51 to accept a pipeline being welded at firing line 63 while the other drum 50 can unwind a previously welded pipeline 53 and launch it via tilting tower 53.

25 The following is a list of suitable parts and materials for the various elements of the preferred embodiment of the present invention.

#### PARTS LIST

	Part Number	Description
	10	reel pipeline lay barge
30	10A	reel pipeline lay barge
	10B	reel pipeline lay barge
	11	hull

	12	bow
	13	stern
	14	deck
	15	superstructure
5	16	port drum
	17	starboard drum
	18	moon pool
	19	tilting tower
	20	pipeline
10	21	bend controller
	22	pipe straightener
	23	tensioner
	24	hold-off clamp
	25	welding station
15	26	welding station
	27	pipe storage
	28	pipe storage
	29	pipe storage
	30	firing line
20	31	arrow
	32	arrow
	33	bending shoe
	34	tensioner
	35	sea bottom
25	36	deck plane
	37	hydraulic cylinder
	38	boom
	39	pinned connection
	40	support
30	41	pinned connection
	42	traveling member
	43	opening

	44	pin
	45	hull
	46	bow
	47	stern
5	48	deck
	49	superstructure
	50	port drum
	51	starboard drum
	52	tilting tower
10	53	pipeline
	54	bend controller
	55	pipe straightener
	56	tensioner
	57	arrow
15	58	welding station
	59	welding station
	60	pipe storage
	61	pipe storage
	62	pipe storage
20	63	firing line
	64	arrow
	65	arrow
	66	bending shoe
	67	arrow
25	68	sea bottom
	69	deck plane
	70	hydraulic cylinder
	71	boom
	72	pinned connection
30	73	support
	74	pinned connection
	75	traveling member

	76	traveling member
	77	track
	78	track
	79	extensible rod
5	80	cylinder
	81	water's surface
	82	track
	83	pinned connection

The foregoing embodiments are presented by way of example only; the scope of the  
10 present invention is to be limited only by the following claims.

## CLAIMS

- 1           1.     A pipeline laying ship comprising:
  - 2           a)     a hull having deck, bow, stern, port and starboard portions;
  - 3           b)     a pair of reels supported upon the hull next to the deck, each reel being  
4 independently rotatable, the reels being generally positioned port and starboard relative to one  
5 another;
  - 6           c)     a pipe joint storage containing multiple joints of pipe;
  - 7           d)     one or more pipeline welding stations on the deck in front of the reels, the pipeline  
8 welding stations being positioned to join said joints of pipe together to form an elongated  
9 pipeline that can be wound upon a selected reel of said pair of reels;
  - 10          e)     a tower for guiding the elongated pipeline as it is unwound from a selected reel, the  
11 tower including at least a bend controller, a straightener and a tensioner; and
  - 12          f)     wherein the tower is movably mounted upon the hull between port and starboard  
13 positions that align the tower with a selected reel, enabling a pipeline to be welded and then  
14 wound upon either of the reels and then unwound from either of the reels for launching to the  
15 seabed via the tower.
- 1           2.     The pipeline laying ship of claim 1 wherein the reels are each supported to rotate  
2 about a generally horizontal axis.
- 1           3.     The pipeline laying ship of claim 1 wherein the reels are generally parallel to one  
2 another.
- 1           4.     The pipeline laying ship of claim 1 wherein the reels are positioned in between the  
2 pipeline welding stations and the tower.
- 1           5.     The pipeline laying ship of claim 1 further comprising track means in the deck  
2 for guiding a lateral movement of the tower.
- 1           6.     The pipeline laying ship of claim 1 wherein the tower is mounted upon a track  
2 that extends laterally across a portion of the deck.



- 1           7.     A pipe laying ship comprising:
- 2           a)     a hull having a deck and bow and opening through which a pipeline can be
- 3     launched for laying on a seabed;
- 4           b)     a pair of reels supported upon the deck next to the deck stern portion each reel
- 5     being independently rotatable, the reels being generally positioned port and starboard relative
- 6     to one another;
- 7           c)     one or more pipeline welding stations on the deck next to the reels, the pipeline
- 8     welding stations being positioned to weld joints of pipe together to form a pipeline that can be
- 9     wound upon a selected reel;
- 10          d)     a tower for guiding a welded pipeline from a selected reel, the tower being
- 11     positioned next to the deck stern and the reels and including at least a bend controller, a
- 12     straightener and a tensioner; and
- 13          e)     wherein the welding stations and tower are each movable between port and
- 14     starboard positions that enable a pipeline to be welded and then wound upon either of the reels
- 15     and to be unwound from either of the reels for launching to the seabed.
- 1           8.     The pipeline laying apparatus of claim 7 wherein the reels are in front of the
- 2     tower.
- 1           9.     The pipeline laying apparatus of claim 8 wherein the tower is behind the welding
- 2     stations and the tower.
- 3           10.    The pipeline laying ship of claim 7 further comprising track means in the deck
- 4     for guiding a lateral movement of the tower.
- 1           11.    The pipeline laying ship of claim 7 wherein the tower is mounted upon a track
- 2     that extends laterally across a portion of the deck.
- 1           12.    A pipe laying ship for welding, and then launching a pipeline to a seabed,
- 2     comprising:
- 3           a)     a hull having deck, bow, stern, port and starboard portions;
- 4           b)     a pair of reels supported by the hull next to the deck, each reel being

5 independently rotatable and configured to hold a section of welded pipeline independently of the  
6 other reel;

7 c) one or more pipeline welding stations on the deck the pipeline welding stations  
8 being positioned to weld joints of pipe together to form a pipeline that can be wound upon a  
9 selected reel;

10 d) a pipe bending device on the deck for bending pipe that is to be wound upon a  
11 selected reel;

12 e) a tower for guiding a welded pipeline to the sea bottom as it is unwound from a  
13 selected reel, the tower including a bend controller, a straightener and a tensioner; and

14 f) wherein the welding stations and tower are movable between positions that enable  
15 a pipeline to be welded and wound upon either the port or starboard reel and to be unwound from  
16 either the port or starboard reel for launching to the seabed.

1 13. The pipeline laying apparatus of claim 8 wherein the reels are in between the  
2 welding stations and the hull stern portion.

1 14. The pipeline laying apparatus of claim 8 wherein the welding stations include a  
2 firing line that travels laterally upon the deck portion of the hull so that a welded pipeline can  
3 be welded at the firing line and wound upon a selected reel coordinated with drum rotation.

1 15. The pipeline laying ship of claim 12 further comprising track means in the deck  
2 for guiding a lateral movement of the tower.

1 16. The pipeline laying ship of claim 12 wherein the tower is mounted upon a track  
2 that extends laterally across a portion of the deck.

1 17. A method of laying a pipeline on a seabed, comprising the steps of:

2 a) progressively joining together lengths of pipe upon the deck of a vessel at a firing  
3 line to form a long pipeline, the vessel having a pair of reels and a tower for launching the  
4 pipeline to the seabed;

5 b) winding the pipeline upon a selected reel of the pair of reels as the lengths of pipe  
6 are joined together at the firing line;

- 7           c)     bending the pipeline before winding the pipeline upon the selected reel;  
8           d)     after a selected reel is wound with a pipeline of selected length, moving the  
9 selected reel along a path in which the pipeline is to be laid, while unwinding the pipeline from  
10 the reel to a tower;  
11          e)     wherein the pair of reels are independently rotatable so that either reel can be  
12 wound with a pipeline in step "a", independently of the other;  
13          f)     moving the firing line in a port to starboard direction that aligns the pipeline as  
14 it is being formed with a selected reel during the winding step "b"; and  
15          g)     moving the tower in a port to starboard direction that aligns the tower with a  
16 selected reel during unwinding step "b".

1           18.    The method of claim 17 wherein the reels rotate about a generally horizontal axis  
2 in step "b".

1           19.    The method of claim 17 further comprising the step of passing the straightened  
2 pipeline through a tensioner.

1           20.    The method of claim 19 further comprising the step of using the combined tension  
2 imposed on the pipeline by the tensioners and drum back tension to compensate for the  
3 suspended weight of the pipeline during its travel from the hull to the seabed.

1           21.    The method of claim 20 further comprising the step of adjusting the tension  
2 depending upon pipe laying parameters that include pipeline characteristics during the pipe  
3 laying operation.

1           22.    The method of claim 20 further comprising the step of adjusting the tension  
2 depending upon pipe laying parameters that include pipeline water depth during the pipe laying

1           23.    The method of claim 22, further comprising using the tower to guide the pipeline  
2 from the selected reel to the seabed.

1           24.    The method of claim 23, further comprising the step of coordinating the tension  
2 applied by the tensioner as the ship moves along the pipeline route to insure that the stresses in

3 the pipeline are maintained within acceptable limits.

1 25. The method of claim 23 further comprising the step of using a hold off clamp to  
2 support the pipeline so that corrosion and insulating coating can be applied thereto.

1 26. The method of claim 18 wherein step "d" includes straightening the pipeline.

1 27. The method of claim 18 further comprising tilting the tower relative to the hull  
2 for adjusting the pipeline launch angle, defined by the angle formed by the pipeline and the  
3 water's surface at the water's surface during a pipeline launch.

1 28. The method of claim 17 further comprising supporting the tower in step "g" with  
2 a track that extends transversely across at least a portion of the deck.

1 29. A pipeline laying ship comprising:

- 2 a) a hull having deck, bow, stern, port and starboard portions;
- 3 b) a pair of reels supported by the hull, each reel being independently rotatable, the  
4 reels being generally positioned port and starboard relative to one another;
- 5 c) a pipe joint storage containing multiple joints of pipe;
- 6 d) one or more pipeline welding stations on the deck near the reels, the pipeline welding  
7 stations being positioned to join said joints of pipe together to form an elongated pipeline that  
8 can be wound upon a selected reel of said pair of reels;
- 9 e) a tower for guiding the elongated pipeline as it is unwound from a selected reel, the  
10 tower including at least a bend controller, a straightener and a tensioner;
- 11 f) wherein the tower is movably mounted upon the hull between port and starboard  
12 positions that enable a pipeline that is wound upon either of the reels to be unwound from either  
13 of the reels for launching to the seabed via the tower; and
- 14 g) wherein the reels are positioned in between the welding stations and the tower.

1 30. The pipeline laying ship of claim 29 wherein the reels are each supported to rotate  
2 about a generally horizontal axis.

1           31. The pipeline laying ship of claim 29 wherein the reels are generally parallel to one  
2 another.

1           32. The pipeline laying ship of claim 29 wherein the reels are positioned in between the  
2 pipeline welding stations and the tower.

1           33. A pipe laying ship comprising:

2           a) a hull having deck, bow and stern portions and port and starboard sides;

3           b) a pair of reels supported upon the deck next to the deck stern portion each reel  
4 being independently rotatable, the reels being generally positioned port and starboard relative  
5 to one another;

6           c) one or more pipeline welding stations on the deck next to the reels, the pipeline  
7 welding stations being positioned to weld joints of pipe together to form a pipeline that can be  
8 wound upon a selected reel;

9           d) a tower for guiding a welded pipeline from a selected reel, the tower being  
10 positioned next to the deck stern and the reels and including at least a bend controller, a  
11 straightener and a tensioner; and

12           e) wherein the tower is movable between port and starboard positions that enable  
13 a pipeline that is wound upon either of the reels to be unwound from either of the reels for  
14 launching to the seabed.

1           34. The pipeline laying apparatus of claim 33 wherein the reels are in front of the  
2 tower.

1           35. The pipeline laying apparatus of claim 33 wherein the tower is behind the welding  
2 stations and the tower.

1           36. The pipeline laying ship of claim 33 further comprising track means in the deck  
2 for guiding a lateral movement of the tower.

1           37. The pipeline laying ship of claim 33 wherein the tower is mounted upon a track  
2 that extends laterally across a portion of the deck.

- 1           38.    A pipe laying ship for welding, and then launching a pipeline to a seabed,  
2 comprising:  
3           a)    a hull having deck, bow, stern, port and starboard portions and an amidships  
4 position;  
5           b)    a pair of reels supported upon the deck in between the hull stern and the  
6 amidships position, each reel being independently rotatable and configured to hold a pipeline  
7 section independently of the other reel;  
8           c)    one or more pipeline welding stations on the deck the pipeline welding stations  
9 being positioned to weld joints of pipe together to form a pipeline that can be wound upon a  
10 selected reel;  
11          d)    a pipe bending device on the deck for bending pipe that is to be wound upon a  
12 selected reel;  
13          e)    a tower for guiding a welded pipeline to the sea bottom as it is unwound from a  
14 selected reel, the tower including a bend controller, a straightener and a tensioner; and  
15          f)    wherein the welding stations and tower are laterally movable between positions  
16 that enable a pipeline to be welded and wound upon either the port or starboard reel and to be  
17 unwound from either the port or starboard reel for launching to the seabed.

1           39.    The pipeline laying apparatus of claim 38 wherein the reels are in between the  
2 welding stations and the hull stern portion.

1           40.    The pipeline laying apparatus of claim 38 wherein the welding stations include  
2 a firing line that travels laterally upon the deck portion of the hull so that a welded pipeline can  
3 be welded at the firing line and wound upon a selected reel coordinated with drum rotation.

1           41.    The pipeline laying ship of claim 38 further comprising track means in the deck  
2 for guiding a lateral movement of the tower.

1           42.    The pipeline laying ship of claim 38 wherein the tower is mounted upon a track  
2 that extends laterally across a portion of the deck.

- 1           43.    A method of laying a pipeline on a seabed, comprising the steps of:
- 2           a)    progressively joining together lengths of pipe upon the deck of a vessel at a firing
- 3           line to form a long pipeline, the vessel having a pair of reels and a tower for launching the
- 4           pipeline to the seabed;
- 5           b)    winding the pipeline upon a selected reel of the pair of reels as the lengths of pipe
- 6           are joined together at the firing line;
- 7           c)    bending the pipeline before winding the pipeline upon the selected reel;
- 8           d)    after a selected reel is wound with a pipeline of selected length, moving the
- 9           selected reel along a path in which the pipeline is to be laid, while unwinding the pipeline from
- 10          the reel to a tower;
- 11          e)    wherein the pair of reels are independently rotatable so that either reel can be
- 12          wound with a pipeline in step "a", independently of the other; and
- 13          f)    moving the tower in a port to starboard direction that aligns the tower with a
- 14          selected reel during unwinding step "b".

- 1           44.    The method of claim wherein the reels rotate about a generally horizontal axis
- 2           in step "b".

- 1           45.    The method of claim 44 further comprising the step of passing the straightened
- 2           pipeline through a tensioner.

- 1           46.    The method of claim 45 further comprising the step of using the combined tension
- 2           imposed on the pipeline by the tensioners and drum back tension to compensate for the
- 3           suspended weight of the pipeline during its travel from the hull to the seabed.

- 1           47.    The method of claim 46 further comprising the step of adjusting the tension
- 2           depending upon pipe laying parameters that include pipeline characteristics during the pipe
- 3           laying operation.

- 1           48.    The method of claim 46 further comprising the step of adjusting the tension
- 2           depending upon pipe laying parameters that include pipeline water depth during the pipe laying

1           49.    The method of claim 47, further comprising using the tower to guide the pipeline  
2 from the selected reel to the seabed.

1           50.    The method of claim 48, further comprising the step of coordinating the tension  
2 applied by the tensioner as the ship moves along the pipeline route to insure that the stresses in  
3 the pipeline are maintained within acceptable limits.

1           51.    The method of claim 49 further comprising the step of using a hold off clamp to  
2 support the pipeline so that corrosion and insulating coating can be applied thereto.

1           52.    The method of claim 43 wherein step "d" includes straightening the pipeline.

1           53.    The method of claim 43 further comprising tilting the tower relative to the hull  
2 for adjusting the pipeline launch angle, defined by the angle formed by the pipeline and the  
3 water's surface at the water's surface during a pipeline launch.

1           54.    The method of claim 43 further comprising launching the pipeline at the vessel  
2 stern.

1           55.    The method of claim 43 wherein the pipeline moves in a bow to stern direction  
2 as it travels from the welding stations to the reels to the tower.

          56.    A pipeline laying ship comprising:  
          a)    a hull having a deck;  
          b)    a pair of reels supported upon the deck, each reel being independently rotatable,  
the reels being generally positioned port and starboard relative to one another;  
          c)    a pipe joint storage containing multiple joints of pipe;  
          d)    one or more pipeline welding stations on the deck next to the reels, the pipeline  
welding stations being positioned to join said joints of pipe together to form an elongated  
pipeline that can be wound upon a selected reel of said pair of reels;  
          e)    a tower for guiding the elongated pipeline as it is unwound from a selected reel, the  
tower including at least a bend controller, a straightener and a tensioner; and



f) wherein the welding stations and tower are movably mounted upon the hull between port and starboard positions that enable a pipeline to be welded and then wound upon either of the reels and to be unwound from either of the reels for launching to the seabed via the tower.

1           57. The pipeline laying ship of claim 56 wherein the reels are each supported to rotate  
2           about a generally horizontal axis.

1           58. The pipeline laying ship of claim 56 wherein the reels are generally parallel to one  
2           another.

1           59. The pipeline laying ship of claim 56 wherein the reels are positioned in between the  
2           pipeline welding stations and the tower.

1           60. A pipe laying ship comprising:

2           a) a hull having a deck and a deck moon pool opening through which a pipeline can  
3           be launched for laying on a seabed;

4           b) a pair of reels supported upon the deck next to the moon pool opening, each reel  
5           being independently rotatable, the reels being generally positioned port and starboard relative  
6           to one another;

7           c) one or more pipeline welding stations on the deck next to the reels, the pipeline  
8           welding stations being positioned to weld joints of pipe together to form a pipeline that can be  
9           wound upon a selected reel;

10          d) a tower for guiding a welded pipeline from a selected reel, the tower being  
11          positioned next to the moon pool and including at least a bend controller, a straightener and a  
12          tensioner; and

13          e) wherein the welding stations and tower are each movable between port and  
14          starboard positions that enable a pipeline to be welded and then wound upon either of the reels  
15          and to be unwound from either of the reels for launching to the seabed.

1           61. The pipeline laying apparatus of claim 60 wherein the moon pool is in front of  
2           the reels.

1           62.    The pipeline laying apparatus of claim 60 wherein the tower is in front of the  
2   moon pool.

1           63.    A pipe laying ship comprising:

2           a)    a hull having a deck having a bow, a stern and a moon pool opening amidships;

3           b)    a pair of reels supported upon the deck next to the moon pool opening and behind  
4   the moon pool opening, each reel being independently rotatable and configured to hold a pipeline  
5   independently of the other reel;

6           c)    one or more pipeline welding stations on the deck behind the reels, the pipeline  
7   welding stations being positioned to weld joints of pipe together to form a pipeline that can be  
8   wound upon a selected reel;

9           d)    a pipe bending device on the deck for bending pipe that is to be wound upon a  
10   selected reel;

11          e)    a tower for guiding a welded pipeline as it is unwound from a selected reel, the  
12   tower including a bend controller, a straightener and a tensioner; and

13          f)    wherein the welding stations and tower are laterally movable between positions  
14   that enable a pipeline to be welded and wound upon either the port or starboard reel and to be  
15   unwound from either the port or starboard reel for launching to the seabed.

1           64.    The pipeline laying apparatus of claim 63 wherein the welding stations are in  
2   between the reels and the hull stern.

1           65.    The pipeline laying apparatus of claim 63 wherein the welding stations include  
2   a firing line that travels laterally so that a welded pipeline can be welded at the firing line and  
3   wound upon a selected reel in a manner that is coordinated with drum rotation.

1           66.    A method of laying a pipeline on a seabed, comprising the steps of:

2           a)    progressively joining together lengths of pipe upon the deck of a vessel at a firing  
3   line to form a long pipeline, the vessel having a pair of reels and a tower for launching the  
4   pipeline;

5           b)    winding the pipeline upon a selected reel of the pair of reels as the lengths of pipe  
6   are joined together at the firing line;

- 7           c)     bending the pipeline to approximate the curvature of the reel before winding the  
8 pipeline upon the selected reel;
- 9           d)     after a selected reel is wound with a pipeline of selected length, moving the  
10 selected reel along a path in which the pipeline is to be laid, while unwinding the pipeline from  
11 the reel and simultaneously straightening the pipeline;
- 12          e)     wherein the pair of reels are independently rotatable so that either reel can be  
13 wound with a pipeline in step "a", independently of the other;
- 14          f)     moving the firing line in a port to starboard direction that aligns the pipeline as  
15 it is being formed with a selected reel during the winding step "b"; and
- 16          g)     moving the tower in a port to starboard direction that aligns the tower with a  
17 selected reel during unwinding step "b".

1           67.     The method of claim 66 wherein the reels rotate about a generally horizontal axis  
2 in step "b".

1           68.     The method of claim 66 further comprising the step of passing the straightened  
2 pipeline through a tensioner.

1           69.     The method of claim 68 further comprising the step of using the combined tension  
2 imposed on the pipeline by the tensioners and drum back tension to compensate for the  
3 suspended weight of the pipeline during its travel from the hull to the seabed.

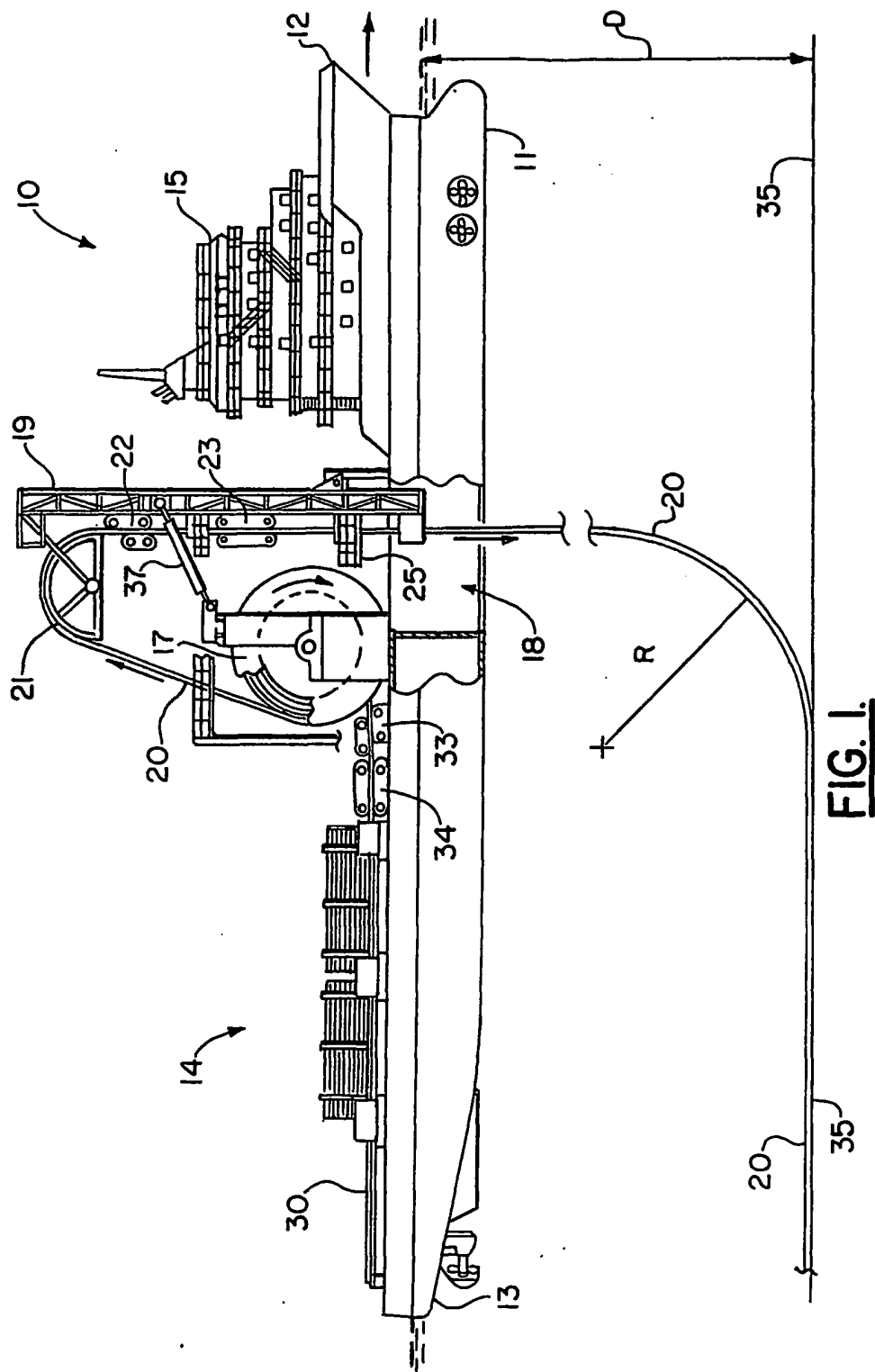
1           70.     The method of claim 69 further comprising the step of adjusting the tension  
2 depending upon pipe laying parameters that include pipeline characteristics and water depth  
3 during the pipe laying operation.

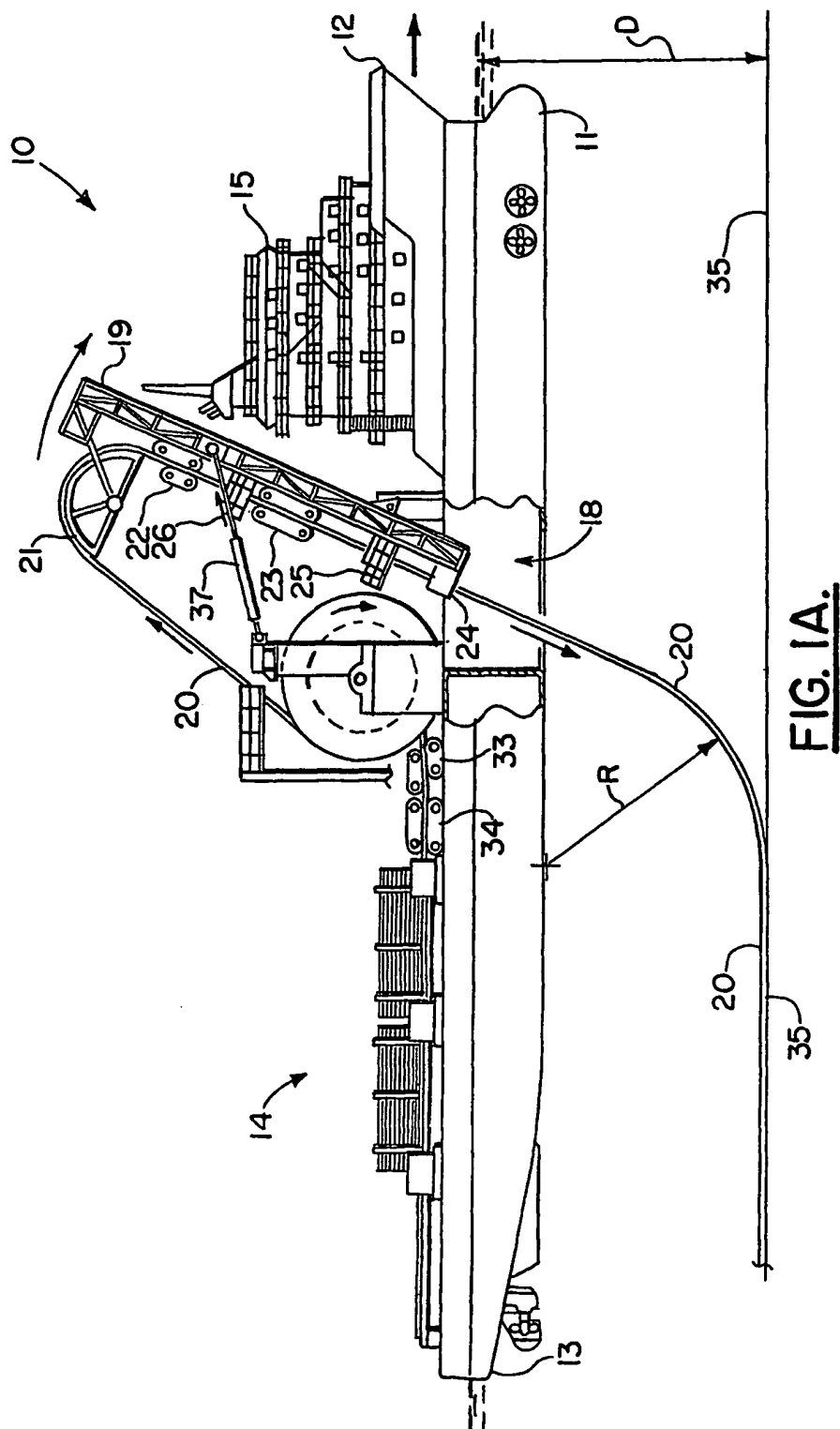
1           71.     The method of claim 70, providing a tower to guide the pipeline from the selected  
2 reel to the seabed.

1           72.     The method of claim 71, further comprising the step of coordinating the tension  
2 applied by the tensioner as the ship moves along the pipeline route to insure that the stresses in  
3 the pipeline are maintained within acceptable limits.

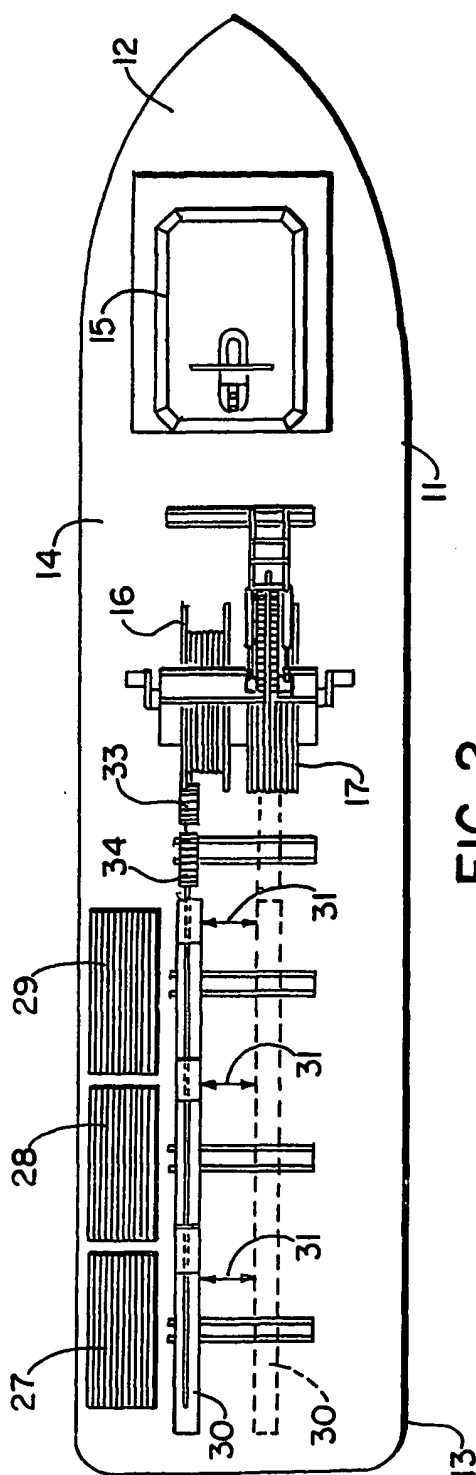
- 1           73.    The method of claim 72 further comprising the step of using a hold off clamp to
- 2   support the pipeline so that corrosion and insulating coating can be applied thereto.

1/12



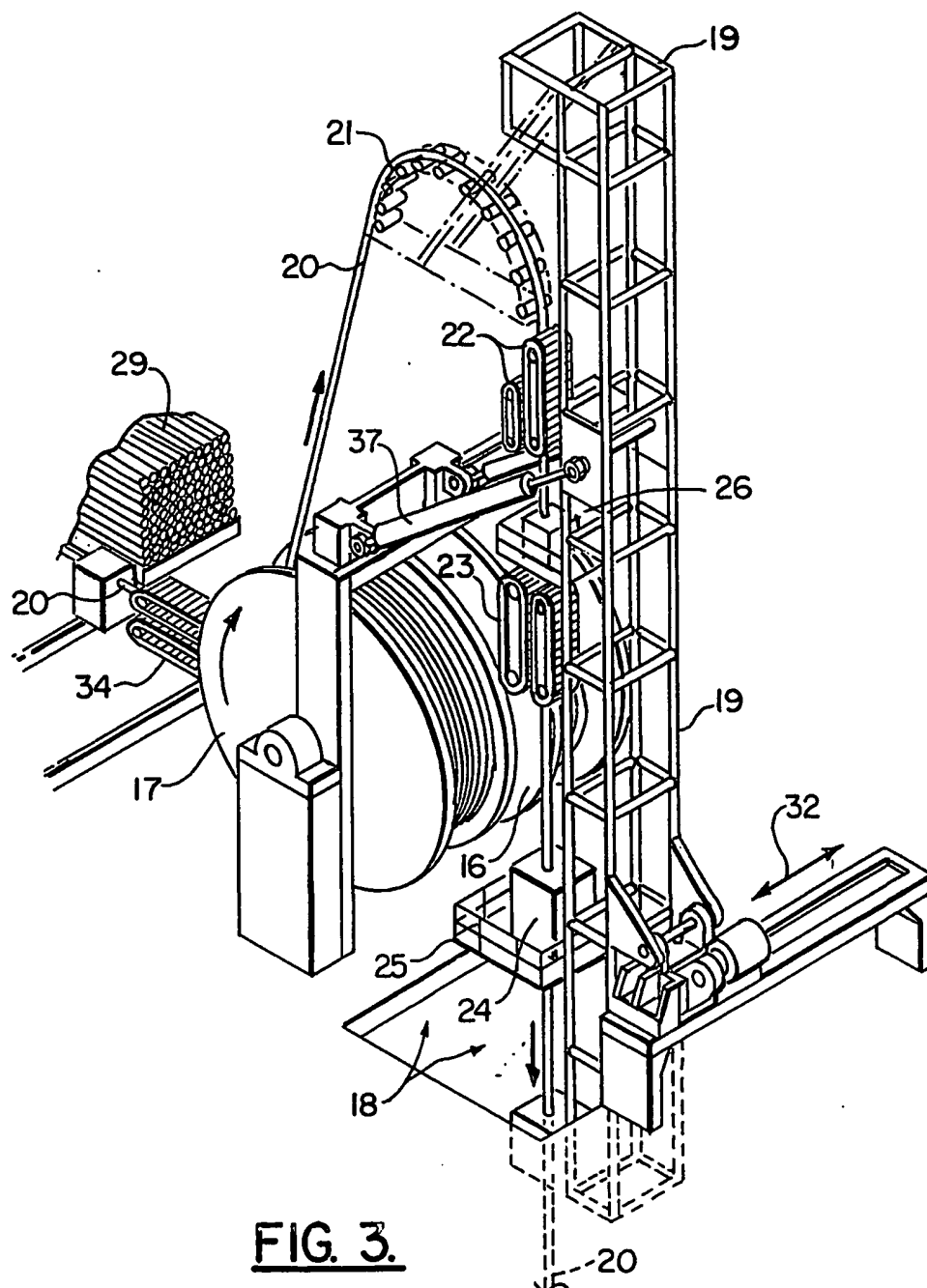


3/12



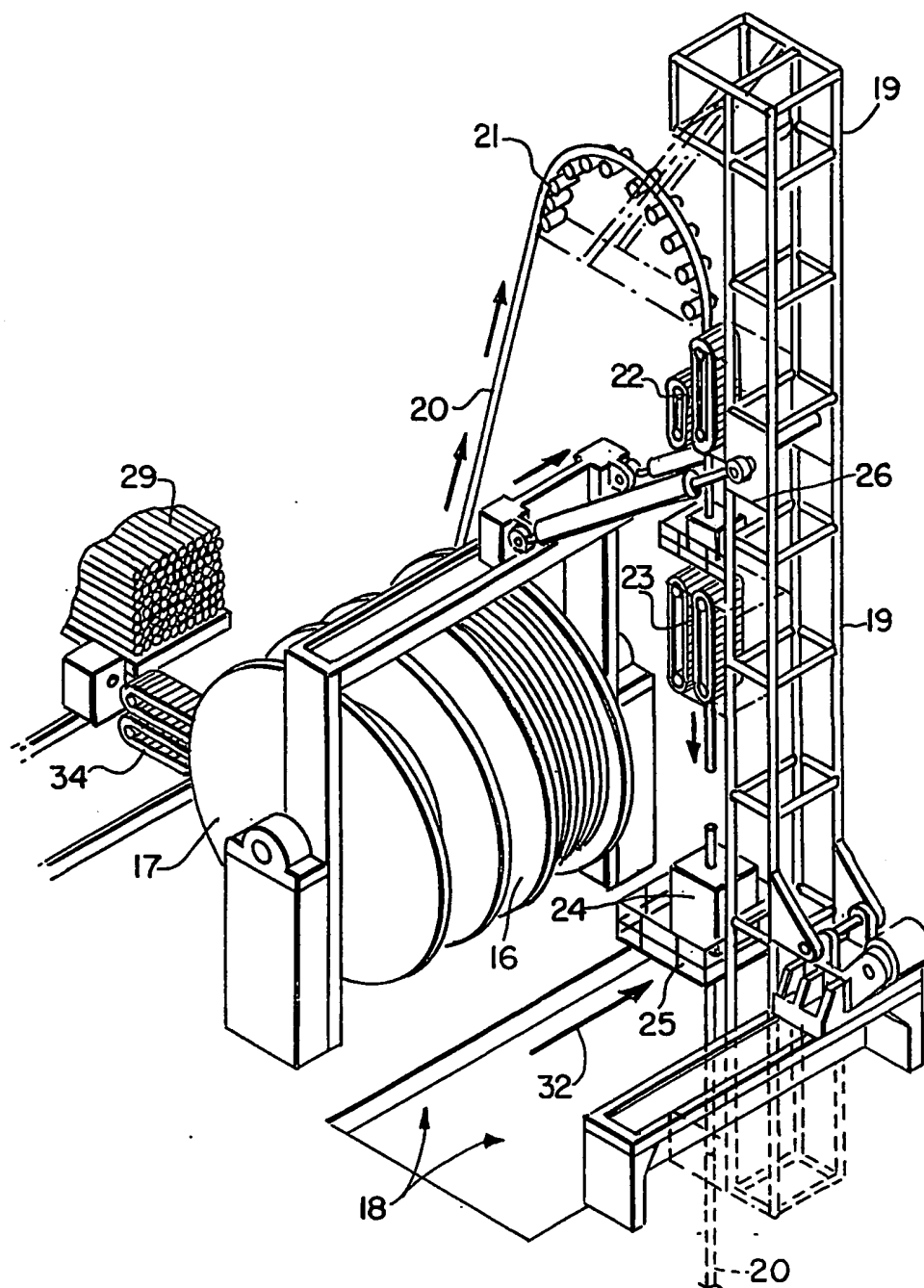
**FIG. 2:**

4/12





5/12

FIG. 4.

6/12

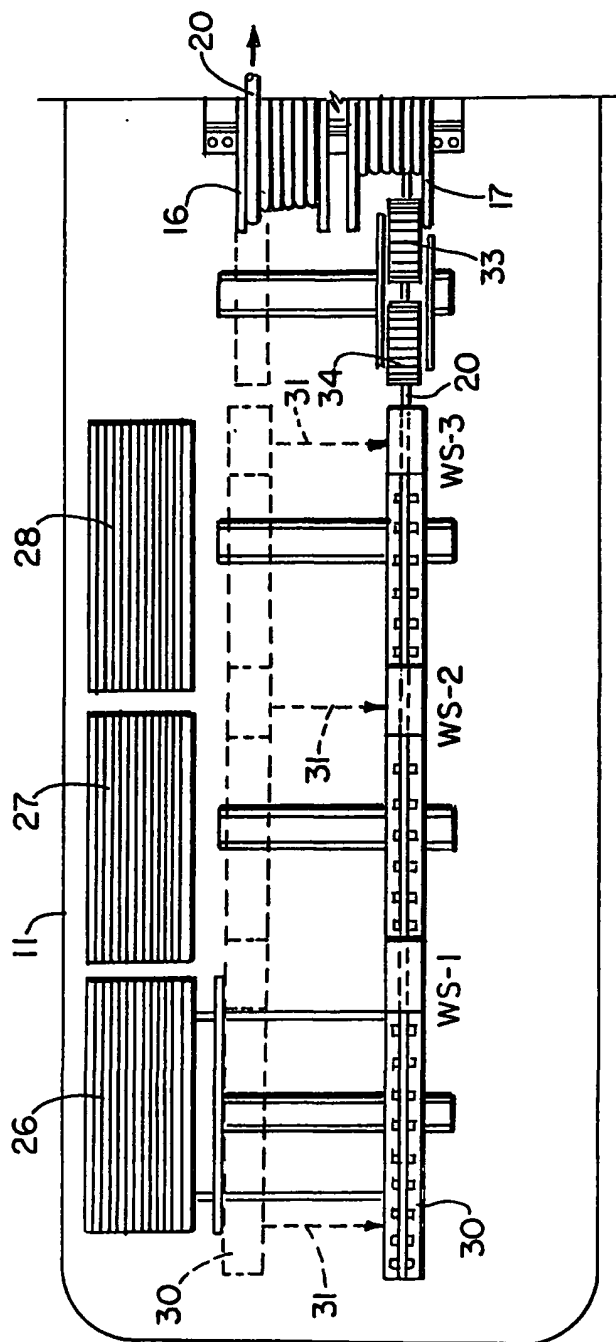


FIG. 5.

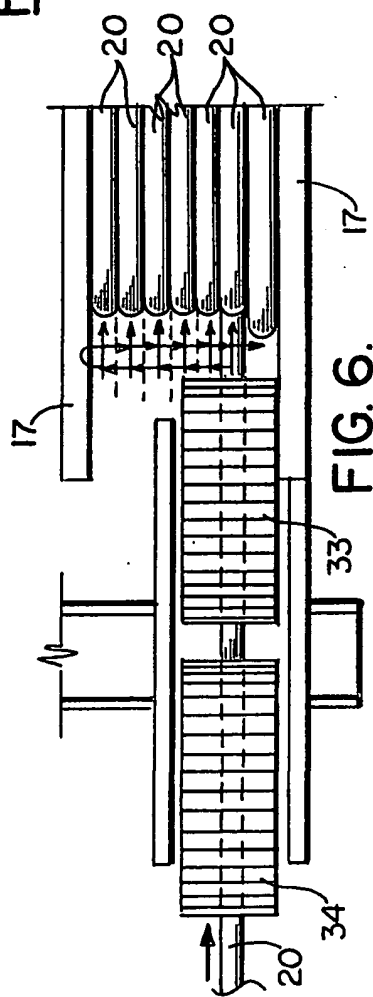
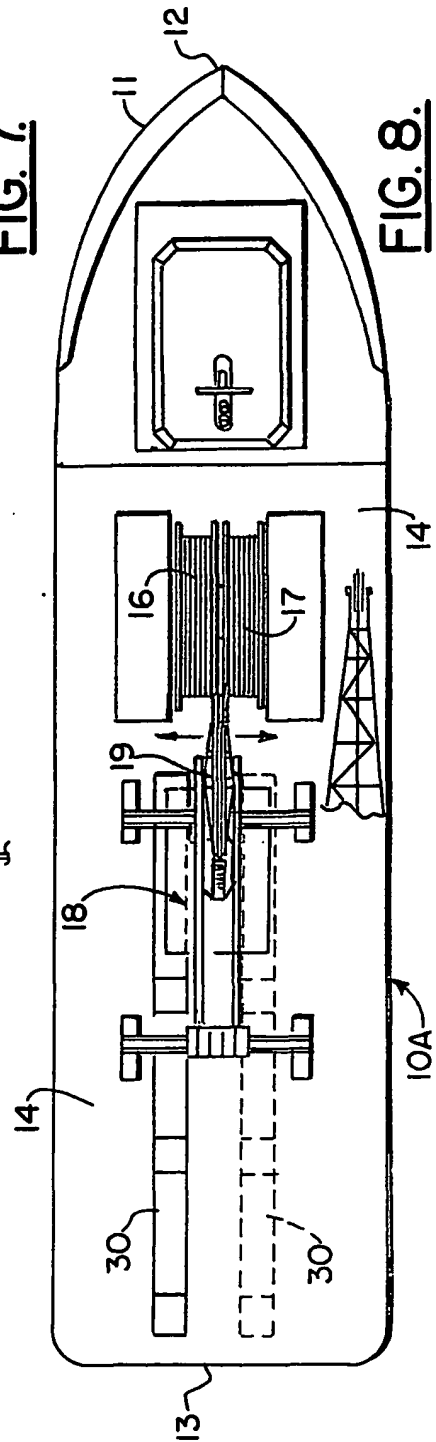
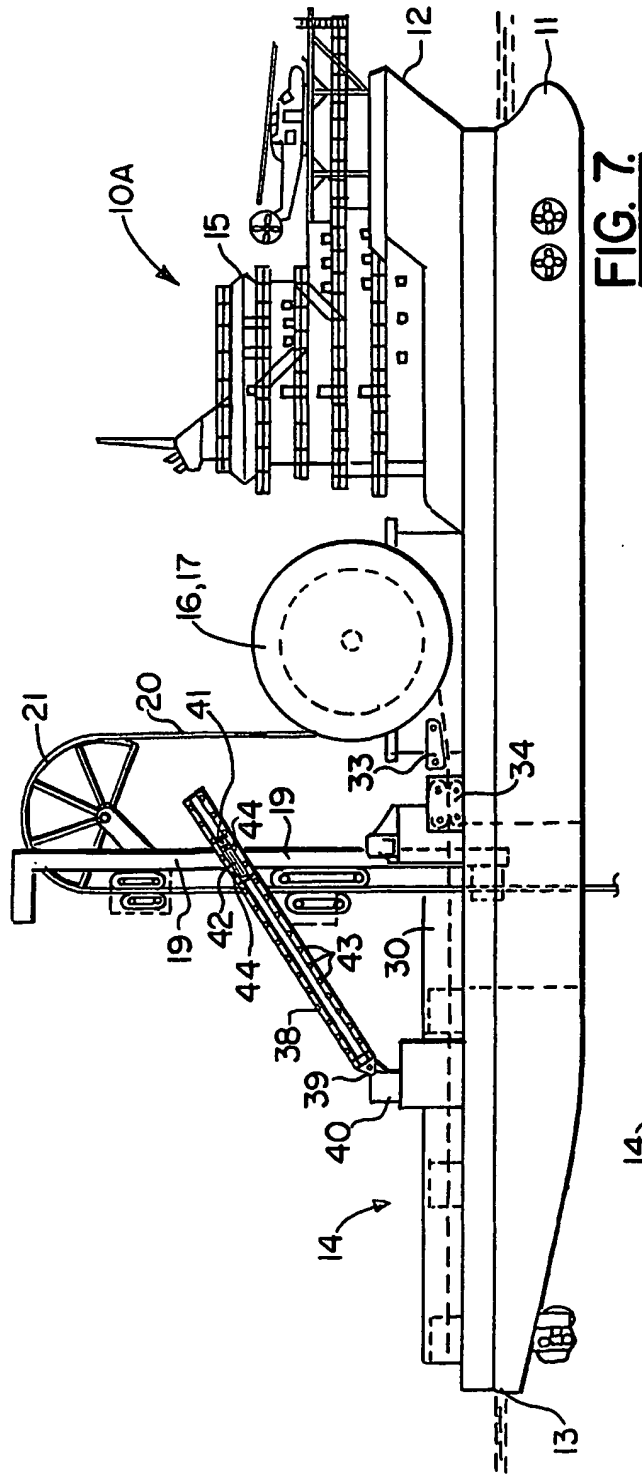


FIG. 6.

7/12



8/12

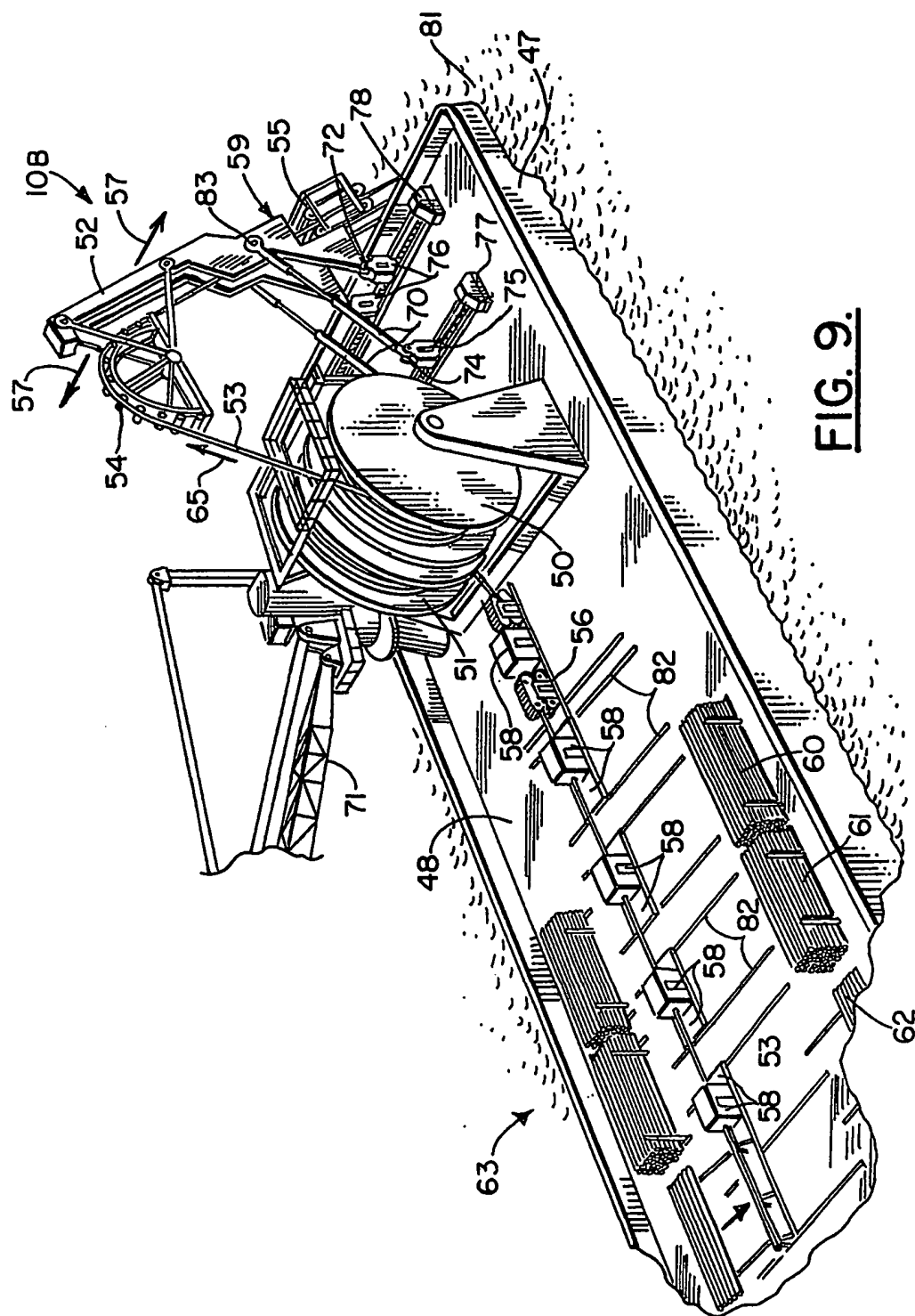


FIG. 9.

9/12

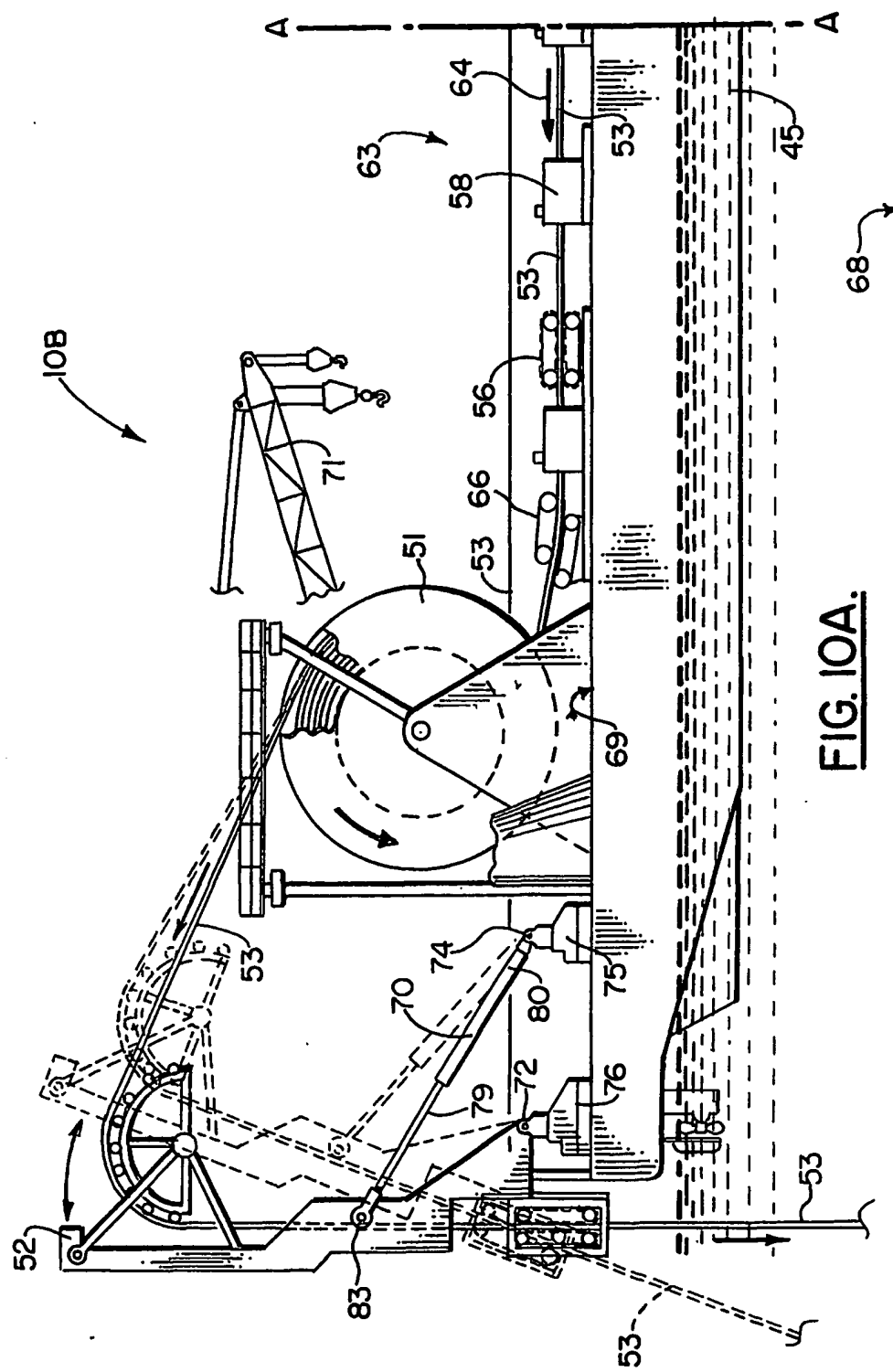
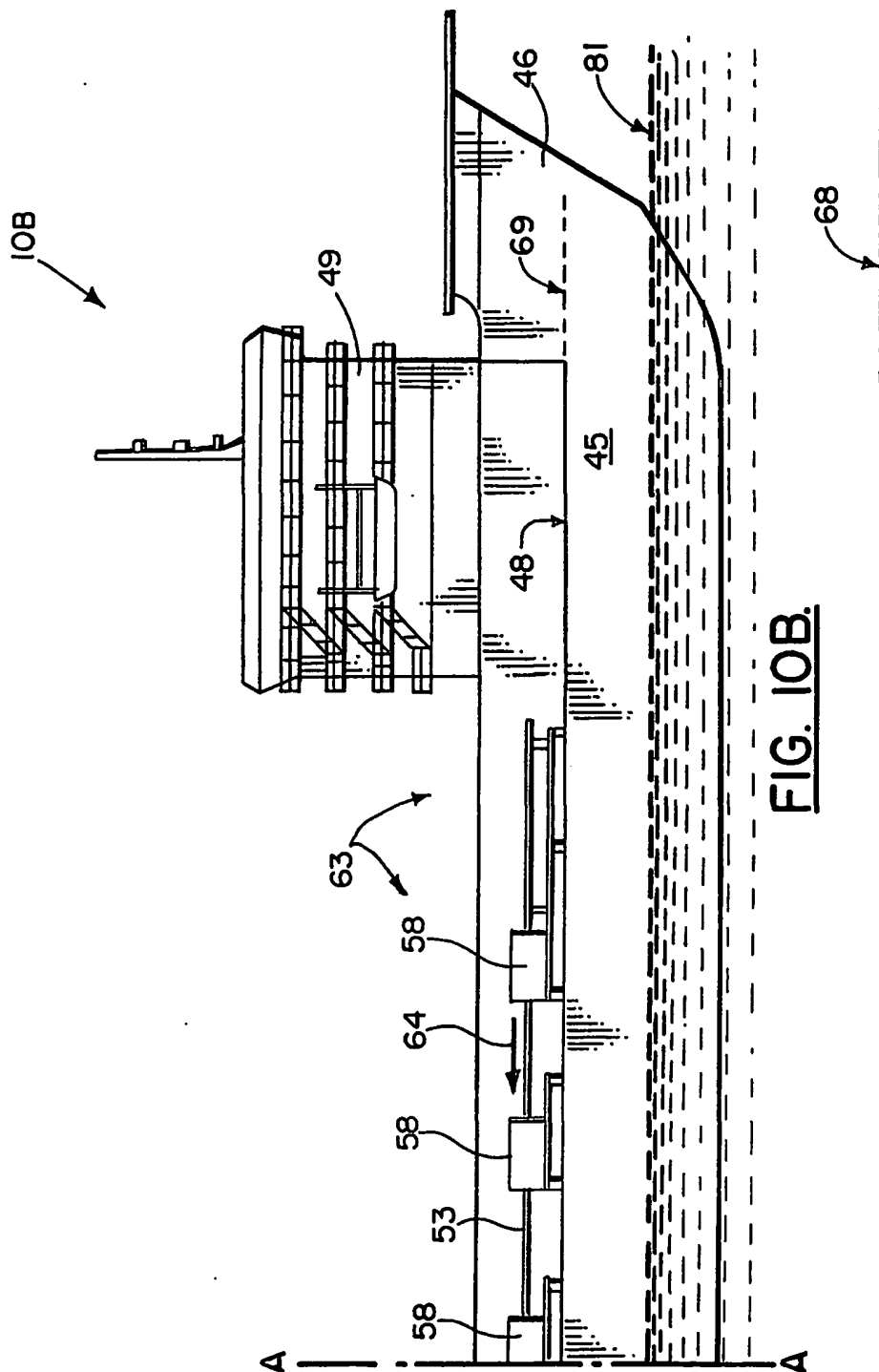
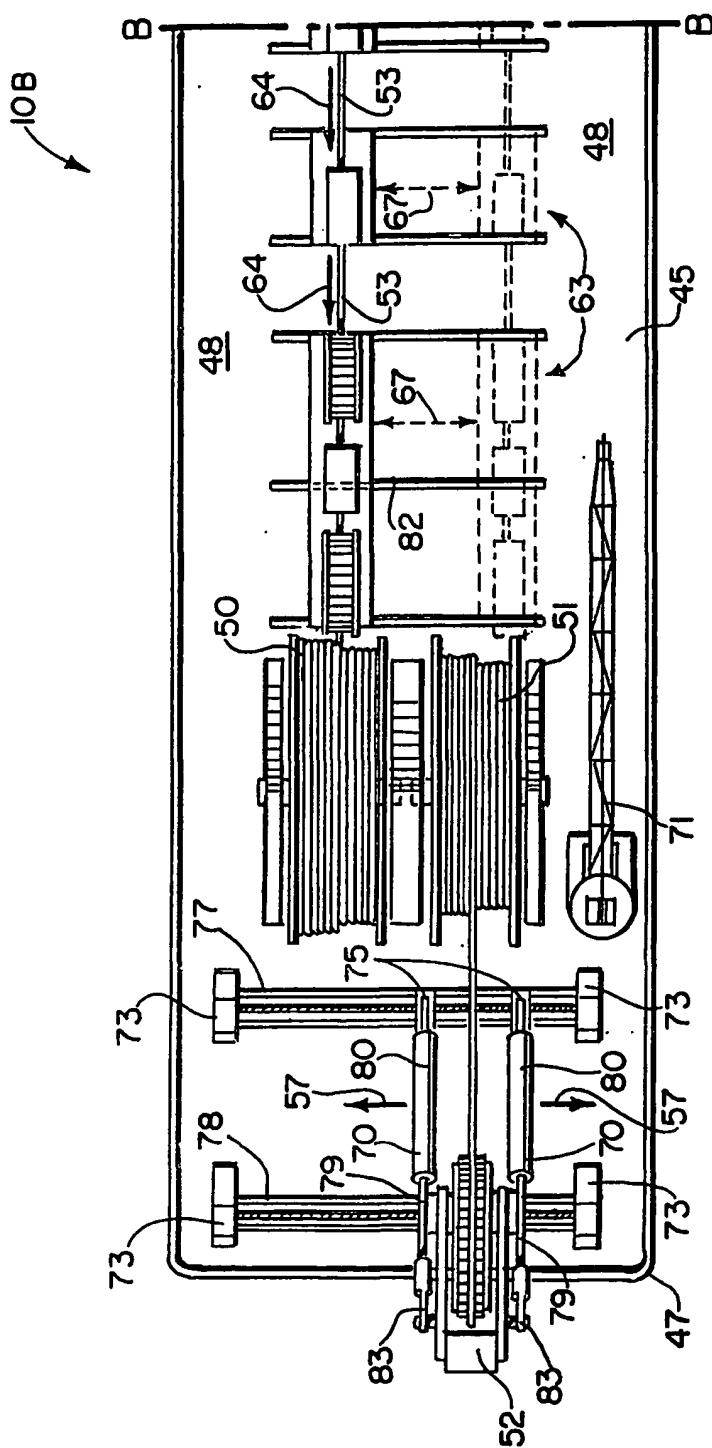


FIG. 10A.

10/12





**FIG. 11A.**

12/12

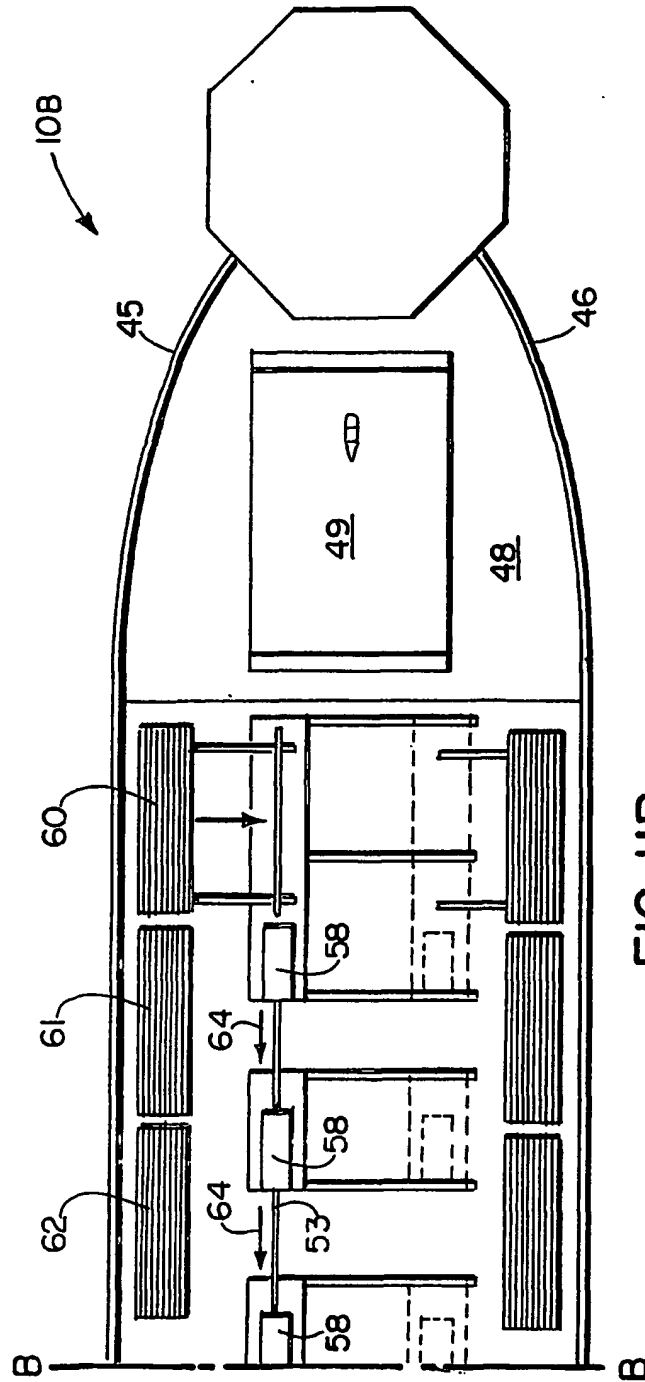


FIG. 11B.



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US02/21253.

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(7) : F16L 1/12; B63B 35/03

US CL : 405/168.3, 170, 166

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 405/168.3, 170, 166, 168.1, 168.2, 168.4, 154.1, 158, 167, 173

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A, P	US 6371,694 A (DE VARAX ET AL) 16 APRIL 2002 (16/4/2002), SEE ENTIRE DOCUMENT.	1-73
A	US 6,056,478 A (MARTIN ET AL) 2 MAY 2000 (2/5/2000), SEE ENTIRE DOCUMENT.	1-73
A	US 4,789,108 A (RECALDE) 6 DECEMBER 1988 (6/12/1988), SEE ENTIRE DOCUMENT.	1-73
A	US 4,659,253 A (JACOBSON) 4 APRIL 1987 (4/4/1987), SEE ENTIRE DOCUMENT.	1-73
A	US 4,448,568 A (GENTRY ET AL) 15 MAY 1984 (15/5/1984), SEE ENTIRE DOCUMENT.	1-73

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:	
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"B" earlier application or patent published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

01 November 2002 (01.11.2002)

Date of mailing of the international search report

03 DEC 2002

Name and mailing address of the ISA/US  
 Commissioner of Patents and Trademarks  
 Box PCT  
 Washington, D.C. 20231

Facsimile No. (703)305-3230

Authorized officer

Frederick E. Lagman

Telephone No. 703-308-1134

**This Page is Inserted by IFW Indexing and Scanning  
Operations and is not part of the Official Record**

**BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☐ FADED TEXT OR DRAWING
- ☒ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☐ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: \_\_\_\_\_

**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.**